7. *On the Effect of Cyclones upon Sea Level.*

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INTRODUCTION.

In a previous paper,[1] the report was given of the result of some investigations on the effect of cyclone frequenting our Pacific Coast, upon the height of the sea level at Aburatubo, Province of Sagami. The present paper may be regarded as a continuation of the above, dealing with the sea level at Aburatubo, as well as at three other stations: (1) Hososima, in Hyûga, (2) Hanasaki, in Province of Nemuro, Hokkaidô, and (3) Wazima, in Noto. The geographical situations of these stations may be seen from Fig. 1. of the paper given in Jap. J. Astr. Geophys., IV (1926), 1.

Instead of taking the monthly distribution of the frequency of cyclonic tracks visiting our coast as in the previous preliminary investigation, the daily variation of the distribution of the cyclones in the oceanic area was examined, taking the data from the Daily Weather Charts of the North Pacific Ocean, published by the Imperial Marine Observatory, Kôbe, Japan.

It was assumed that any elementary area of a cyclone on the ocean will contribute an elementary variation of the height of the sea level at the station considered, which is proportional to the area of the element and is a function of the distance of the element from the station. For the first approximation we may define the cyclonic area as bounded by an closed isobar with a certain pressure and regard all the elementary areas within the area equivalent, as regards their contribution to the sea level, whereas the area on the outside of the said boundary is of no effect. Again, the effect of the distance may be accounted for if we divide the ocean into successive zones by drawing concentric circles with the station as centre, and the cyclonic area as defined above be allotted with a proper weight according as the distance of the zone in which the cyclonic area lies.

The method of procedure adopted is as follows.

On the Daily Weather Chart, the oceanic area was divided into n equal

1) T. TERADA and S. YAMAGUTI, *Proc. Imp. Acad.*, **4** (1928), No. 8; *Bull. I.E.I.C.*, **11** (1928), No. 3.

sections by radii vector with the given station as the origin and with $\theta = n \times 15°$, $n=1, 2, 3, \ldots$, where the prime vector and the last radius were taken nearly tangential respectively to the coast lines on both sides of the station. The area was again divided into circular zones by seven concentric circles with radii of 300, 600, 900, ... 2100 km. respectively, except in the case of Wazima for which five circles were drawn (300–1500 km.). The area of each section thus divided by successive radii vector and concentric circles was taken as an unit area for measuring the cyclonic area, so that the nearer the area is situated to the station, the greater is the weight attached to that elementary area. The *"reduced" cyclonic area* as defined above, i.e. Σ (actual area)/(area of the section) $= \Gamma$, which has fallen within a circle of 900 km. radius, or 2100 km. radius was denoted by Γ_3, or Γ_7 respectively, the effect of the azimuth being assumed immaterial. The boundary of the cyclonic area was taken at the isobar with 756 mm. Hg. In order to take account of extremely deep depression, the areas within the isobars of 748 mm. Hg were alloted with the double weight.

To save the labour, use was made of a celluloid plate, upon which were drawn the radii vector and concentric circles above explained. This was applied on the Chart and the cyclonic area as above defined was counted. Thus the values of Γ_3 or Γ_7 for every day were read off with no great labour.

The data of the sea level for the said stations were kindly placed at my disposal by the Military Land Survey Department through the intervention of the Authorities of the Imperial Earthquake Investigation Committee, except the data for Hanasaki from December 16, 1924 to the end of the year 1927, which were kindly furnished by the Imperial Marine Observatory, Kôbe. The latter data are grouped according to the Moon's ages, namely each monthly mean covers an interval between the days next to the days of successive full moon.

According to the estimation of the Military Land Survey Department, the values of the sea level after the Great Earthquake of Sept. 1, 1923, were reduced by 1394 mm., assuming the upward displacement of the earth crust on that occasion to be of this amount.

The comparisons were made of the cyclonic area reduced as above, firstly with the monthly mean sea level, secondly with the daily mean sea level, and lastly with the yearly mean sea level, during a period of five years (1923–1927).

On the other hand, the comparison was also tried of the monthly mean value of Γ_7/Γ_3 with the corresponding value of $\Sigma|\Delta L|/\Sigma|\Delta b|$, corresponding to the method taken in the previous report,[2] for 1923 and 1924 in the case of Aburatubo and Hososima, and for 1923 alone in the case of Wazima and Hanasaki.

Method of Investigation.

a) On plotting the monthly mean sea level as ordinates against the month taken as abscissa, it may be seen at first glance that there exists a conspicuous annual fluctuation with a minimum in March or April and a maximum in September or October, which may be caused partly by the variation of the sea water temperature[3] and probably also by that of ocean current and some other meteorological effects.

It was considered suitable to apply at first some correction due to the systematic annual variation of sea level directly due to the annual variation of pressure, before entering into the investigation of the specific effect of the cyclonic area. On plotting the barometer-sea level diagram, however, we noticed that the barometric pressure has a complicated fluctuation with the irregular periods of about two months or more, besides the annual variation, it is not practicable to correct the deviation of sea level for the annual barometric variation. Hence, in order to eliminate the averaged systematic annual variation, regardless of its causes, and make the effect of the cyclones more prominent, it was preferred to take, for the comparison with the cyclonic data, the value of the deviation, ΔL from the mean of each monthly value of sea level for 25 years (1900–1924). For Aburatubo, the mean for 24 years (1900–1923) was available.

As to the corresponding value of the cyclonic area, the value of the deviation, $\Delta\Gamma_3$ from the mean monthly value of Γ_3 for the five years, 1923–1927, was subjected to examination.

For Aburatubo, the zone for Γ_3 (i.e. with 900 km. radius) extends to Hokkaidô and to Kyûsyû, while the region for Γ_7 reaches Saghalien toward N and Formosa toward S, the aperture of the entire sector, θ, being 210°. For Hososima, the prime vector touches the Kurile Islands Arc, and the last vector, the southern coast of China, making $\theta=195°$. For Hanasaki, the prime vector also touches the Kurile Islands, and the last vector was so chosen as to pass the south end of Kyûsyû, θ being 180°. For

2) Prof. TERADA and S. YAMAGUTI, *Proc. Imp. Aacd.*, 4 (1928), No. 8; ΔL is the deviation of the sea level from the corresponding mean and Δb the deviation of the barometric pressure.

3) T. NOMITU and M. OKAMOTO, *Mem. Coll. Sci., Kyôto Imp. Univ.*, A. **10**, No. 3 (1927), 125.

Wazima, the prime vector is directed to Hokkaidô, and the last to the north end of Kyûsyû, θ being 150°. In this last case, the region for Γ_3 includes Japan Sea only, and that for Γ_5 includes the Chinese Waters besides the above. For all these stations, the area of the land which are occupied by the cyclone was put out of account.

Thus, firstly, the ΔL-curve and the $\Delta\Gamma_3$-curve were drawn with the months as the common abscissa as shown in Fig. 1. The two curves show in most cases some evident parallelism with each other, though some discrepancies are observed during some epoch at some stations. Next, a diagram was plotted for each station, in which the monthly values of ΔL and $\Delta\Gamma_3$ are taken respectively as the ordinate and abscissa, as shown in Fig. 2. The zero line of ΔL being transformed by an amount of 27, −8, 70 and 38 in millimeters for Aburatubo, Hososima, Hanasaki and Wazima respectively in order to make $\Sigma\Delta L=0$. It will be seen that the points plotted are rather

ΔL from 25 years' mean and $\Delta\Gamma_3$

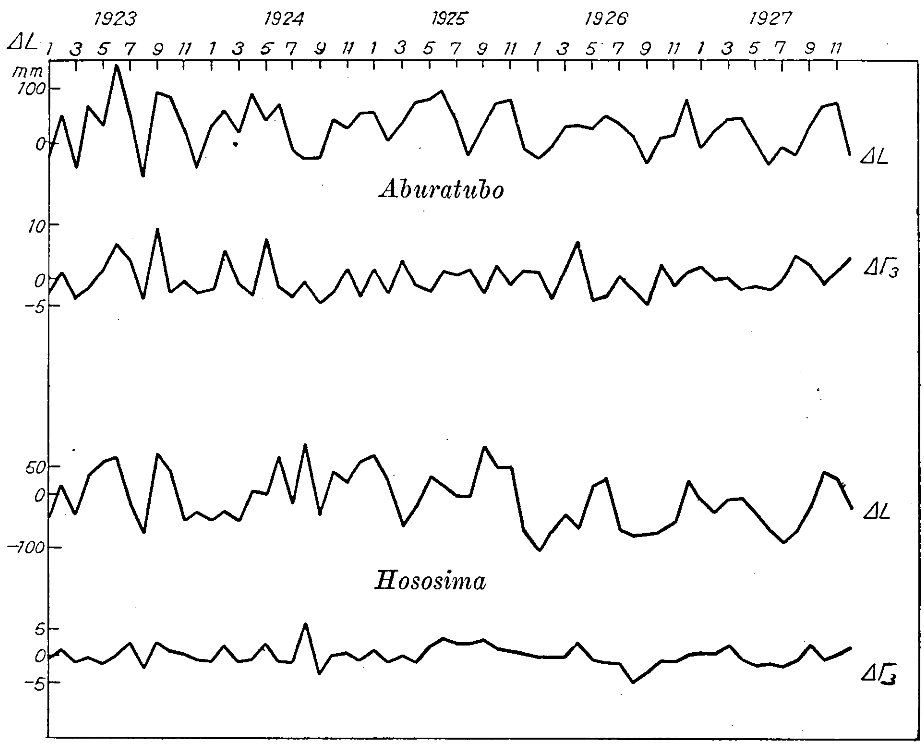

Fig. 1 *a*.

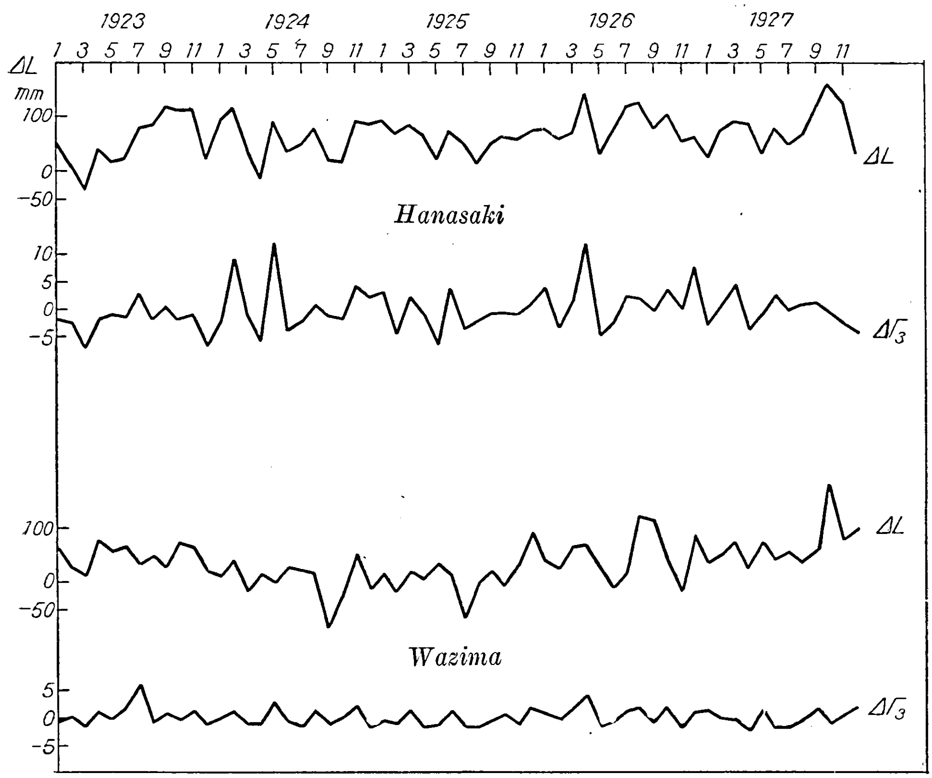

Fig. 1 *b*.

widely scattered; still, the points show a tendency to be distributed in an elliptic area of which the major axis is inclined to the axis of abscissa at an angle somewhat similar for different stations.

b) Next, with the purpose of finding out the "*cyclonic factor*", i.e. a factor giving the normal ratio of $\Delta L'$ to $\Delta \Gamma_3'$, the relation between the *daily* values of the sea level and the area which we denote by, L' and Γ', were examined. On plotting the daily values of the sea level as ordinates against the dates taken as abscissa, the deviation from the straight line connecting the mean point of the four days at the beginning of the month to that of the four days at the end, was measured for every day and was denoted by $\Delta L'$, of which the positive value means the elevation of the sea level relative to the earth crust. Taking this value of $\Delta L'$, which is considered to be thus nearly freed from the astronomical tides with long period, and the *reduced area* Γ_3' as the ordinate and abscissa respectively, we

ΔL from 25 years' mean and $\Delta\Gamma_3$ from 5 years' mean.

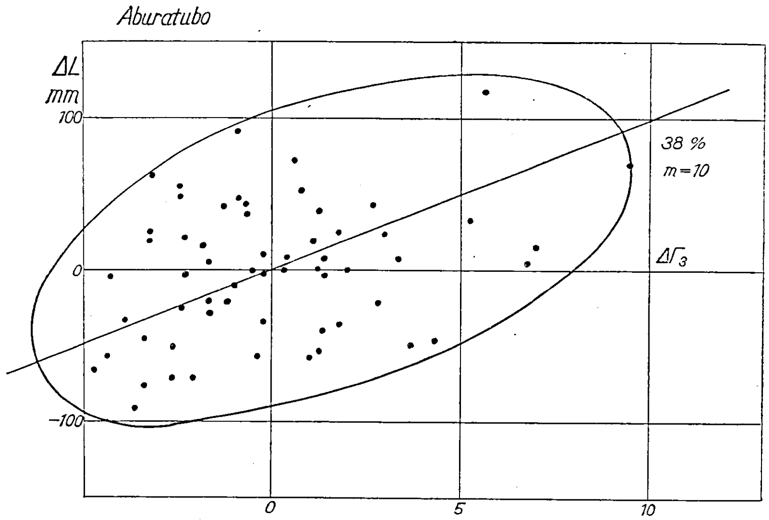

Fig. 2 *a*.

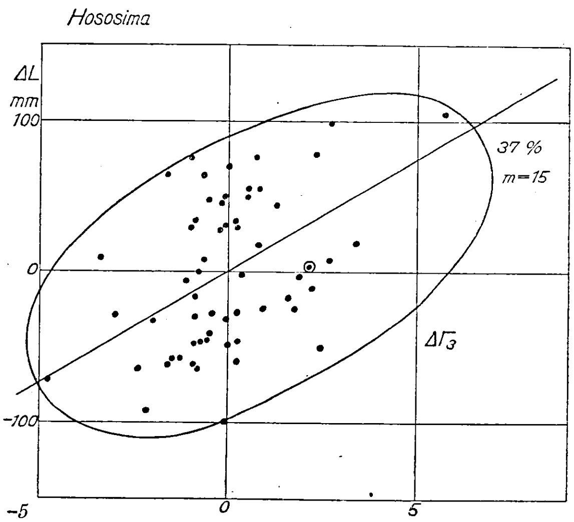

Fig. 2 *b*.

ΔL from 25 years' mean and $\Delta\Gamma_3$ from 5 years' mean

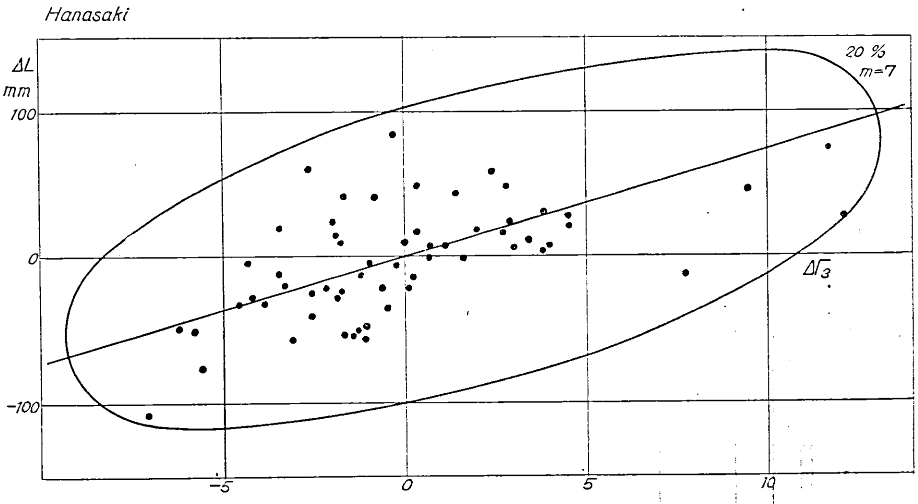

Fig. 2 *c*.

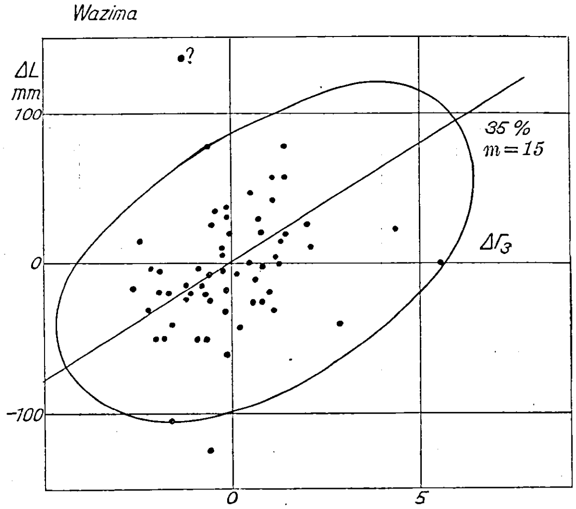

Fig. 2 *d*.

plotted the point for every day, making one diagram for each month of two years (1923, 1924). The diagrams thus obtained for each month show a pretty regularity in general, though a few diagrams show a rather wide scattering of the points.

Hence, only the mean for 12 months was taken combining all the points together. For this purpose, the mean of $\Delta L'$'s falling within the range

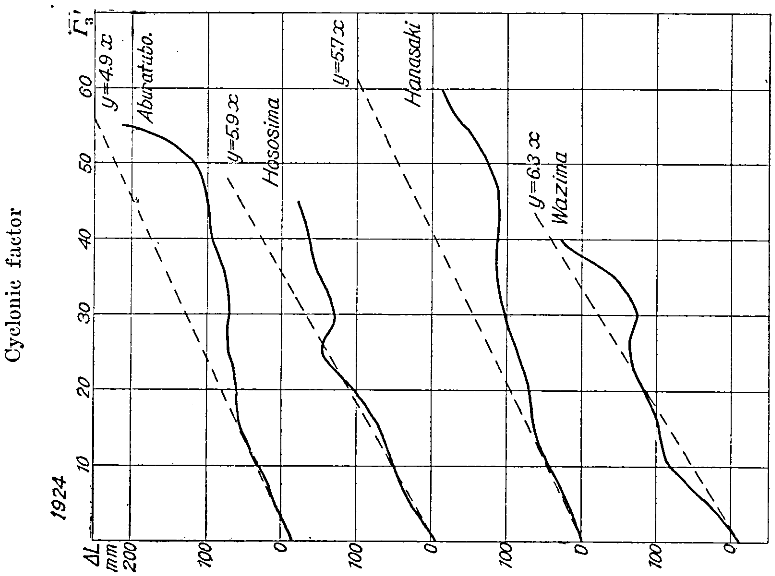
Cyclonic factor
1924
ΔL
mm
200
100
0
10
20
30
40
50
60
Γ'3
y=4.9x
Aburatubo.
y=5.9x
Hososima
y=5.7x
Hanasaki
y=6.3x
Wazima

Fig. 3 b.

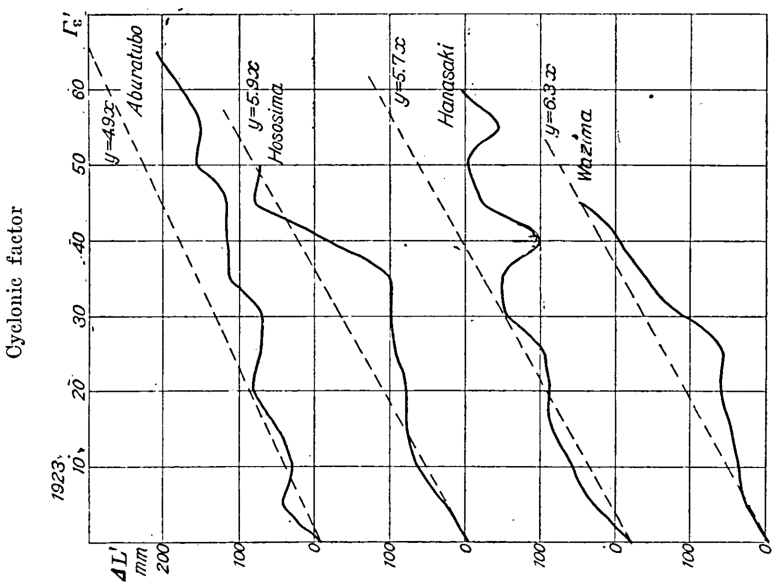
Cyclonic factor
1923
ΔL'
mm
200
100
0
10
20
30
40
50
60
Γ'3
y=4.9x
Aburatubo
y=5.9x
Hososima
y=5.7x
Hanasaki
y=6.3x
Wazima

Fig. 3 a.

$\Gamma_3' = x-5$ to $x+5$ was assigned to correspond to the value of $\Gamma_3' = x$; only the mean of $\Delta L'$'s falling on the axis $\Gamma_3' = x = 0$ was treated specially, namely taking their mean to correspond to $x=0$. The resulting diagrams are shown in Fig. 3, in which the straight lines are obtained from the weighted means

Yearly mean sea level and reduced cyclonic area.

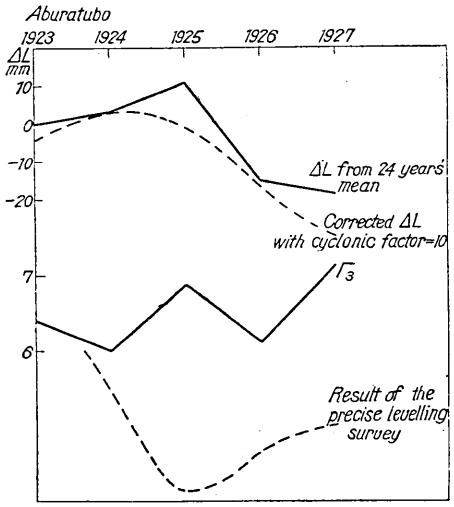

Fig. 4 *a*.

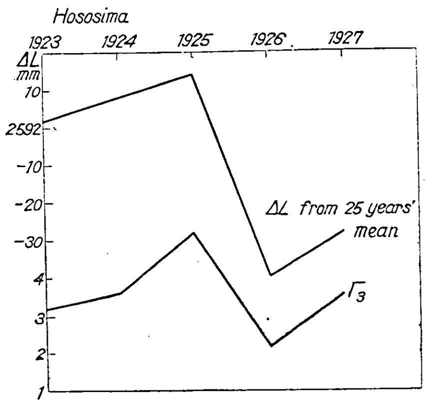

Fig. 4 *b*.

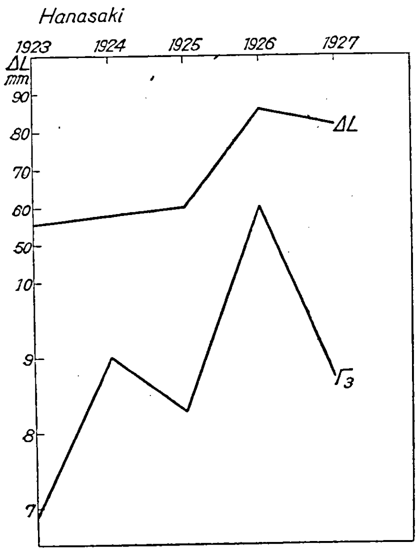

Fig. 4 *c*.

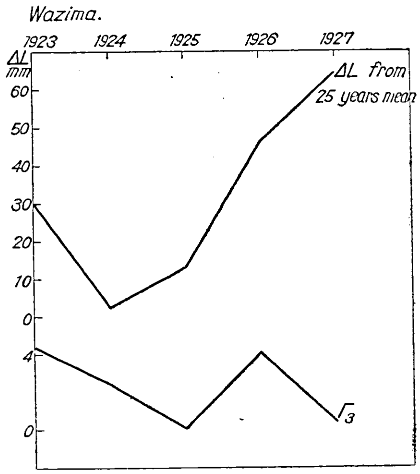

Fig. 4 *d*.

of $\Delta L'$, by applying the method of least squares. From the inclination of these straight lines, the "*cyclonic factors*" are estimated to be 4.9, 5.9, 5.7 and 6.3 for Aburatubo, Hososima, Hanasaki and Wazima respectively.

c) The deviation of the yearly mean sea level from the mean value of 25 years (24 years for Aburatubo) was also compared with the corresponding mean value of Γ_3 as shown in Fig. 4. A general tendency to parallelism may scarcely be overlooked.

d) To verify the result given in the previous report, the value of $\Sigma|\Delta L|/\Sigma|\Delta b|$ above described was compared with the value of Γ_7/Γ_3 in the diagram shown in Fig. 5, in which a general correlation will be observed.

e) Lastly, picking up the most conspicuous cyclonic days, on which the values of the sea level have shown extremely large elevations, among 731 days of the years 1923 and 1924, the relation between the so-called "*barometric factor*" and the "*cyclonic factor*" was investigated.

For this purpose, the differences which we denote by Δb, $\Delta\Gamma_3''$ and $\Delta L''$, of b, Γ and L respectively between the day before and the day in question, and also these differences between the day in question and the day after were estimated. From these data, the values of $\frac{\Sigma\Delta L''}{\Sigma\Delta b}$, $\frac{1}{n}\sum\frac{\Delta L''}{\Delta b}$ and $f=\frac{\Sigma\Delta L''}{\Sigma\Delta\Gamma_3''}$ were calculated. The results are shown in Table I.

TABLE I.

Stations	The Day before			The Day after		
	$\frac{\Sigma\Delta L''}{\Sigma\Delta b}$	$\frac{1}{n}\sum\frac{\Delta L''}{\Delta b}$	$f=\frac{\Sigma\Delta L''}{\Sigma\Delta\Gamma_3''}$	$\frac{\Sigma\Delta L''}{\Sigma\Delta b}$	$\frac{1}{n}\sum\frac{\Delta L''}{\Delta b}$	$f=\frac{\Sigma\Delta L''}{\Sigma\Delta\Gamma_3'}$
Aburatubo	15.7	30	5.0	12.0	14.1	3.8
Hososima	22.5	41	9.7	20.5	23.3	7.5
Hanasaki	12.3	15.3	5.4	14.2	16.8	6.8
Wazima	25.6	52	12.7	13.5	19.5	6.4

Discussion of Results.

We can see from Fig. 3, that the cyclonic effect upon the *daily* mean sea level is conspicuous. On the other hand, Fig. 2 which refers to the *monthly* mean sea level, shows some apparent discrepancy in some epochs for some stations. This apparent discrepancy may be due to the reason that in some month, for instance, such as August, 1923 for Aburatubo, the

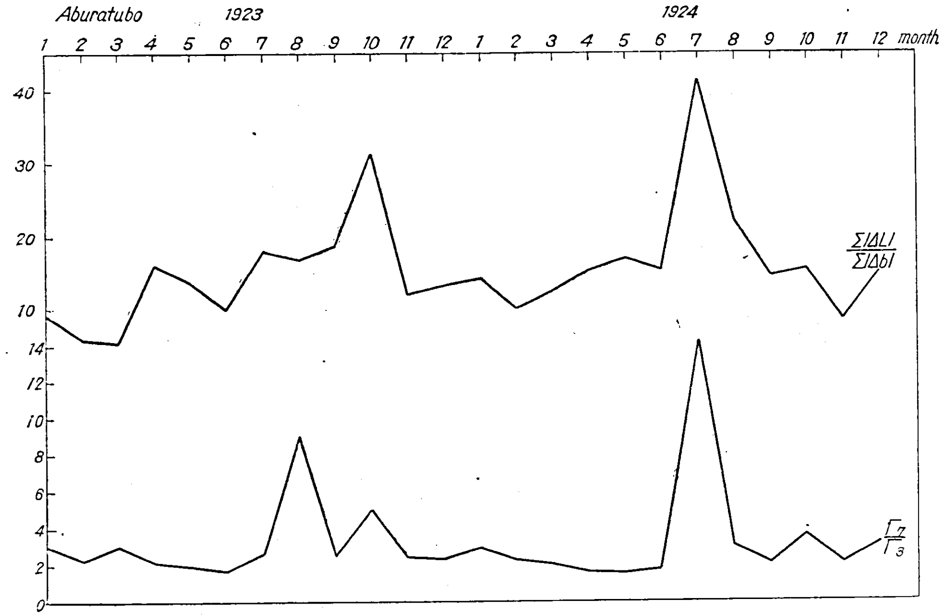

Fig. 5 *a*.

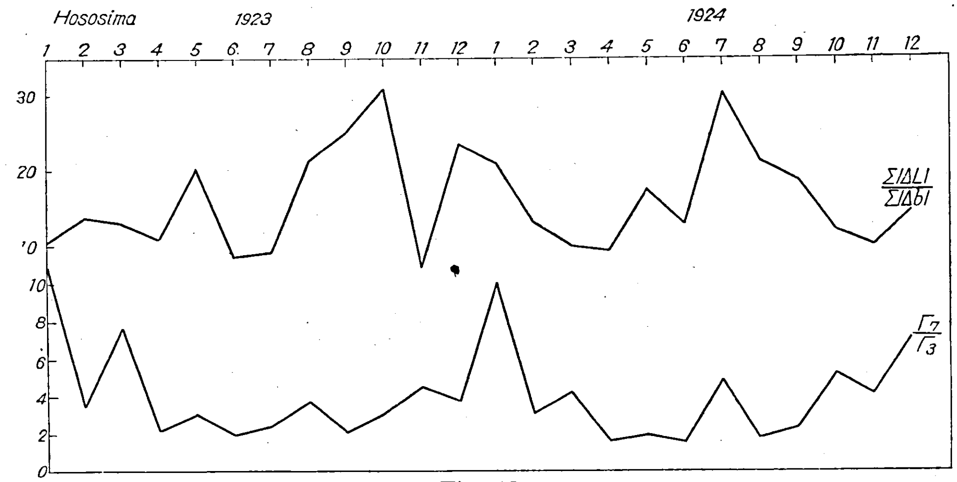

Fig. 5 *b*.

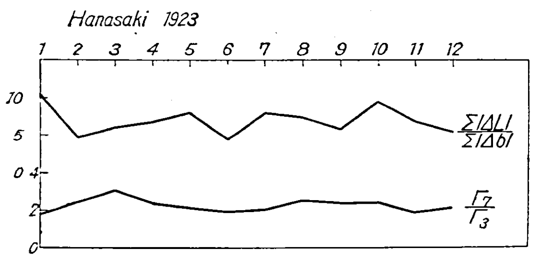

Fig. 5 *c*.

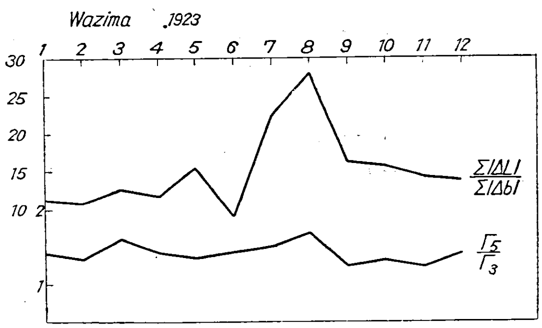

Fig. 5 *d*.

number of cyclonic days is exceptionally small and therefore the cyclonic effect is effaced by the predominant effects of the other meteorological disturbances, such as those caused by anti-cyclones, the winds, etc., when the mean of 30 days is taken.

Again, we also noticed, in the process of obtaining the "*cyclonic factor*" from the daily values, that the month in which the cyclonic days are predominant, for instance, September and October, 1923, for Aburatubo, the relation between the sea level and the cyclonic data was most conspicuous.

For Wazima, the parallelism of ΔL-curve to the $\Delta \Gamma_3$-curve is better generally in winter time than in summer, a fact of which may probably be connected with the frequency of winter cyclones passing over Japan Sea.

Moreover, we noticed for all the stations that, on calm days, the values of $\Delta L'$ are scattered widely above and below the origin along the axis of $\Gamma_3'=0$. This mean value i.e. the mean $\Delta L'$ for $\Gamma_3'=0$, is always negative and its absolute amount is small, being mostly less than 20 mm. for any month for all stations. The case with $\Gamma_3'=0$ includes those cases in which there may exist some sensible effect of anticyclone prevalent in the neighbouring sea. Hence, if this effect of anticyclone be conspicuous, we may expect the above mean $\Delta L'$ for $\Gamma_3'=0$ to be large. The fact that this is small, may therefore mean that the effect of anti-cyclone upon the mean sea level is comparatively small.

After all, we can draw an ellipse enclosing all the points of which the major axis is inclined by a certain angle to the axis $\Delta L=0$, as shown in Fig. 2. From the angle of inclination thus estimated, we may obtain a "*cyclonic factor*" with respect to the monthly value. The factors thus determined roughly are 10, 15, 7 and 15 for Aburatubo, Hososima, Hanasaki and Wazima respectively. Again, counting the number of points which fall in the second and the fourth quadrant of $\Delta \Gamma_3 - \Delta L$ diagram shown in Fig. 2, we can find that the numbers of months in which the correlation is in opposite sense, are only 38, 37, 20 and 35 per cent. for Aburatubo, Hososima, Hanasaki and Wazima respectively.

Hanasaki, which shows the greatest value of the correlation coefficient is, in fact, mostly frequented by cyclones among those four stations. The existence of even this degree of correlation between the two quantities $\Delta \Gamma_3$ and ΔL, in spite of the numerous disturbances superposed owing to many other meteorological factors, will show how conspicuous is the effect of cyclone upon sea level.

Looking at Fig. 5, we recognize a fair correlation between $\Sigma|\Delta L|/\Sigma|\Delta b|$ and Γ_7/Γ_3 for each of the four stations, though there exist some exceptional months, for which the exact reason is not yet known. Again, the parallelism in the curves of the above quantities for 1923 is not generally so good as in the case of 1924, for Aburatubo and Hososima, while for the curve of ΔL and $\Delta \Gamma_3$, the contrary is the case. A plausible explanation may be sought in the fact that the amount of fluctuation of the barometric pressure over a wide area of the sea neighbouring the mareographic station may be considerably larger than at the land station of which the barometric data are taken, and that the effect upon the sea level of a cyclone which passed through the region nearer than 900 km. from the mareographic station is associated with the positive elevation of the sea level, while the effect of a cyclone which passes over remote part of the sea further than 1200 km. from the station may correspond to the depression of the sea level at the station. In general, it will be seen that when the fluctuation of the barometric factor is small, the fluctuation of the value Γ_7/Γ_3 is also small as shown in Fig. 5*c*, for the case of Hanasaki.

From the Table I, we may be able to say the following:

If we define the "*barometric factor*" by the mean of $\Delta L''/\Delta b$, the value of the factor is more than twice or four times the theoretical value for the days when the cyclone is approaching, and less than twice the theoretical value when the cyclone is going away; this holds at least for the three stations, Aburatubo, Hososima and Wazima, excepting Hanasaki. In the case of Hanasaki, it is somewhat greater than the theoretical value and, moreover, it is less when the cyclone is approaching than when it is receding.

All these facts suggest some effect of wind accompanying the cyclone, keeping in mind that most cyclones frequenting our coast of Honsyû come from the south-western quarter of the North Pacific Ocean and proceed towards the north-eastern part, while in the case of those cyclones considered to affect the sea level of Hanasaki, the relations are otherwise, as the cyclones coming from NW are predominant.

A similar discrepancy may also be found with regard to the "*cyclonic factor*" of which the values found in Table I are somewhat greater, for all stations, than those derived from the daily values of $\Delta L'$ and Γ_3'.

Though the results shown in Fig. 4, are not yet conclusive and a more sufficient data based on many years' investigation are necessary in order to enable us to infer anything definite, we may at least be convinced that a certain physcial connection exists between the yearly mean sea level and the corresponding yearly mean "*reduced cyclonic area*" of the cyclones frequenting the sea area within 900 km. of the station. Especially for Hososima the parallelism is so good that the sea level curve may be reduced very flat if the proper correction due to the cyclone be applied.

For a trial, the yearly mean sea level of Aburatubo was corrected for the cyclonic effect with the cyclonic factor of 10, which is estimated from the inclination of the major axis in Fig. 2*a*, and the corrected height of the annual sea level is drawn with dotted curve in Fig. 4*a*. This corrected curve agrees, in character as well as in magnitude, with the variation of the height of the bench mark at Aburatubo deduced from the result of the precise levelling survey carried out by the Land Survey Department after the Great Earthquake of Sept. 1., 1923, the datum line at Hudisawa being assumed to be constant.

At any rate, it seems advisable in following the annual variation of the sea level as a means for inquiring after the true crustal deformation, to take account of the cyclonic factor as here investigated, which can not be generally negligible, though the other meteorological disturbances may be considered to cancel each other in a whole year.

The effect of cyclone seems to become faint when its centr recedes to a certain distance remoter than 1000 km. from the station. It may be suspected that beyond this range the effect may change its sign, though a further research is wanted to ascertain this point.

As Wazima is situated on the Japan Sea coast, a special consideration will be made with respect to this station. The mean velocity of water current entering the Japan Sea basin through the Straits of Tusima was calculated, which may occur when a cyclone is raging on the Japan Sea and consequently its mean level is raised by a certain amount. The velocity is given by

$$V=\frac{A\,.\,dh}{S\,.\,t},$$

where A is the surface area of the Japan Sea, dh the elevation of the sea level, S the sectional area of the straits, and t the time. We get $V=0.070$ metre/sec., the values of A and S, being estimated from the hydrographical chart, and dh and t assumed as follows:

$$A=1.46\times10^{12}\ \text{m.}^2;\ S=2.41\times10^{7}\ \text{m.}^2;\ dh=0.1\ \text{m.};\ t=24\ \text{hours.}$$

This value of current velocity is by no means abnormal, and may be admitted by sea men.

Our original purpose of the present series of investigation regarding the meteorological disturbances was, however, otherwise than dealing with these oceanographical problems. Returning now to our proper problem, it was wanted to eliminate the effect of barometric pressure, winds and the other meteorological factors from the observed variation of the sea level and to detect any possible vertical movement of the earth crust which was suspected to have occurred on the occasion of the recent Great Earthquake of Sept. 1, 1923. In the present paper, the new correction due to the specific effect of cyclone was investigated, besides the corrections due to the pressure and gradient[4] (winds) which were already applied to the daily values of the sea level for the four stations, Aburatubo, Hososima, Hanasaki and Wazima for 1923, and for the first two stations, also for 1924. For Aburatubo, the corrections due to the cyclone as well as those due to the pressure and gradient were applied for the two years, 1923 and 1924. As it was found, however, that the corrections due to the pressure and gradient are generally small and affect the general feature of the sea level curve to a small extent, it is considered convenient for the present purpose to apply the cyclonic correction only, to save the labour in the case when the data for a long range of years is to be examined. Thus, we took also a series of data for the five years, 1923–1927, for which only the correction due to the cyclone was applied, and thus corrected values of the monthly mean sea level were plotted against the month, the datum line being brought down by an amount of 1000 mm. in order to make $+\Delta L$ represent an elevation of the sea level.

Comparing the two curves with and without the barometric and gradient correction for the two years (1923, 1924), they show scarcely any essential difference in the general character of the curve, as already mentioned above. The monthly values corrected for the cyclonic factor=10 show still a systematic annual fluctuation. To eliminate the latter, the deviation from the five year mean of each month was taken and plotted in the diagram shown in Fig. 6.

The days, on which a remarkable earthquake has happened near the station, (within the region of Kwantô District), are marked in the figure along with the curve by $\otimes$ and $\times$, corresponding to the strong and the weak shock respectively. The data for the earthquakes were taken from the Monthly Summary Report of the Central Meteorological Observatory in Japan. It appears that the strong shocks have a tendency to occur after the minimum point, or in ascending stage of the curve and the weak shocks, in descending stage, as far as may be judged from the scanty data.

It appears also that the graph shows a sensible downward displacement[5]

4) T. Terada and S. Yamaguti, *Jap. J. Astr. Geophys.*, 4, No. 1 (1926).

5) *I.e.* on the assumption that the amount of the elevation of the crust immediately after the Earthquake as given by the Land Survey Department, and employed here in transferring the datum line, is correct.

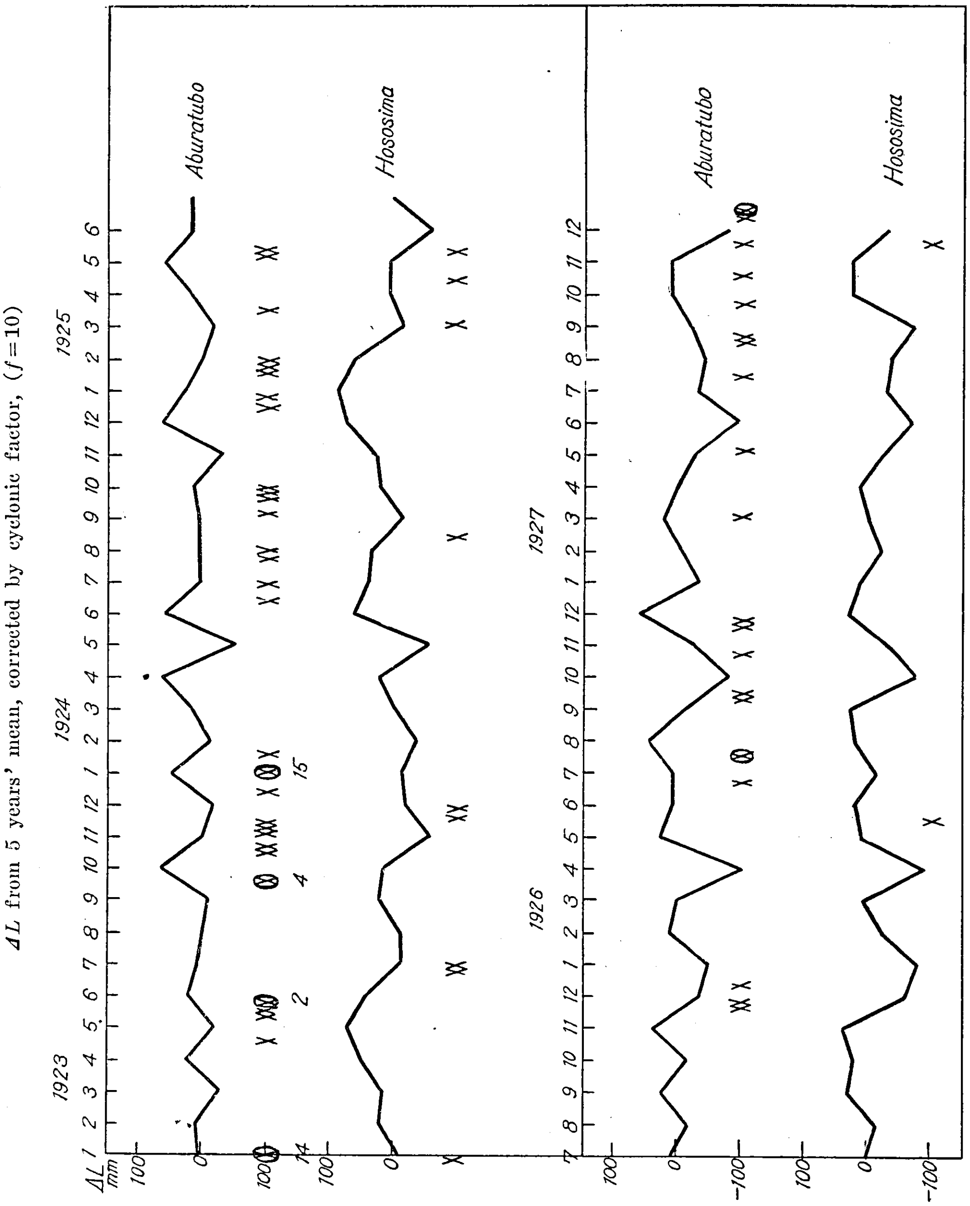
ΔL from 5 years' mean, corrected by cyclonic factor, (f=10)
Aburatubo
Hososima
1923
1924
1925
1926
1927
ΔL mm

Fig. 6.

of the crust for a certain interval of time after the Great Earthquake of Sept. 1, 1923. The crust seems to have gradually returned to its original height at about Sept., 1924, and the upward motion is seen to have continued to the end of the investigating year, 1927. These points are worth notice and may stimulate a further research on this line.

The data for Hososima were also taken and corrected with the cyclonic factor=15 above obtained, and similarly treated for the sake of comparison, the datum line being brought down by an amount of 2800 mm. in order to make $+\Delta L$ represent an elevation of the sea level, as shown in Fig. 6.

Comparing these two curves for Aburatubo and Hososima, it will be seen that the parallelism is good for some months, which may probably be due to the effect of Ocean current, "*Kurosio,*" upon sea level, as suggested by Prof. T. Terada.

There remains still many factors governing the height of the sea level which must be investigated before we may detect any actual deformation of the earth crust from the mareographic data. It is only a step toward this direction which has been here taken. The investigations are being continued and the further results will be reported in a future communication.

In conclusion, I wish to express my best thanks to Prof. T. Terada under whose supervision the entire work has been carried out and who has given me many useful suggestions throughout the course of my investigation.

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7. 低氣壓の海水面に及ぼす影響に就て

山　口　生　知

日本近海に現れたる低氣壓の痕跡の數と相模の國油壺に於ける海水面との間に密接なる關係あることは既に寺田博士及び山口生知の名を以て、震災豫防調査會紀要第十一卷第三號に於て報告したり。今回の研究は其繼續作業にして低氣壓の海水面に及ぼす影響を今少しく數量的に見出さんとし即ち低氣壓係數を見出さんとして次の如き方法に依り調査を進めたるものなり。即ち神戸海洋氣象臺發行の日々の天氣圖上に於て問題の地點を中心とし半徑三百キロメートル、六百キロメートル、九百キロメートル、二千百キロメートルを有する七つの同心圓を畫き又一方十五度づゝの動徑を引きたり。最初の動徑及び最後の動徑は問題の地點より兩方面に於ける海岸線に接する樣にひけり、斯くて之等の同心圓と動徑とに依つて圍まれたる扇形の面積を單位の面積と定め日本近海に現れたる低氣壓の海洋上に於ける面積の毎日の價を計算せり。此面積を基とし日々の平均海面、月々の平均海面及び一年間の平均海面等に及ぼす低氣壓の影響を大正十二年より昭和二年迄の五ヶ年間に亘り調査したるに何れも著しき影響ある事を見出したり。されば本來の目的即ち大正十二年九月關東

大地震の前後に於て地盤の上下したるや否やを平均海水面を基準として推定する爲には觀測中より種々の氣象の影響を取去る可き問題に立歸り月々の價より見出したる低氣壓係數を以て月々の平均海面に低氣壓に依る修正を加ふる事を試みたり、其結果月々の平均水面曲線は甚しく上下したる個所消え失せ餘程平坦となり大地震直後地盤は少しく降下しそれより次第に復舊を續け一ケ年後即ち大正十三年九月に元の高さとなり、以後昭和二年終迄静に上昇を續けつゝある如き形勢を窺ふ事を得。以上は油壺に就ての調査なるが日向の國細島に就ても全く同樣の調査を行ひたる結果の月々の平均海面曲線を比較し見るに尙未だ海流の影響の如きもの殘存する狀況見え其方の研究は目下繼續中なり。尙此外能登の國輪島及北海道根室の國花咲に於ても同樣の調査を行ひたるに何れも海水面に及ぼす低氣壓の影響の著しき事を見出せり。
