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SOMMAIRE

Observatoire de Géophysique

COLLÈGE JEAN-DE-BRÉBEUF

MONTRÉAL

OBSERVATOIRE DE GEOPHYSIQUE

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FOREWORD

Jean-de-Brébeuf college has just completed a new Geophysical observatory in Montreal. It will have two sections: one of Seismology, the other of Radio-Meteorology. Here is a brief description of its equipment and the purpose of this new observatory.

The Seismological section is equipped with three Benioff Seismographs giving, by photographic recording, the three components of the earth's motion during a seismic disturbance: N-S, E-W and Vertical. As each one of the Benioff pendulums can record two traces by means of two distinct galvanometers (short and long period), six different recordings for each seismic shock will be available for geophysical research. The spectrum of the earth's vibrations produced by an earthquake will, therefore be reproduced more completely than with three recordings only.

Regional seismicity, together with the so called teleseisms and microseisms, will be investigated by the seismological department.

We give at the end of this first issue of our GEOPHYSICAL BULLETIN the constants of the instruments and an analysis of the shocks recorded since April 1956.

We are pleased to add that the beginning of our studies in this branch of geophysics was made possible by the encouragement and help of the Dominion Seismological Observatory (Department of Mines and Technical Surveys).

Already in 1954 they kindly assisted us by placing at our disposal a Willmore seismograph, a three components photographic recorder and a good chronometer. Once more, we extend to the Dominion Observatory our sincere thanks for their valuable help.

We also extend our most sincere thanks to a few other people whose generosity has enabled us to acquire a complete set of Benioff Seismographs together with an underground constant temperature vault set on Ordovician Limestone (Trenton Limestone). All that will make of Brebeuf College a seismological observatory of international utility.

Recordings are made in a separate room by means of a shielded electric cable which was especially made for us and which brings to the galvanometers the currents produced by the seismographs.

The Radio-Meteorological section has planned a rather extensive research program and, we think, uses a technique somewhat different from others.

We intend to study the behaviour of the lower atmosphere (troposphere) by means not only of thermodynamic but also of electromagnetic factors. For this, we have at our disposal all the equipment of a meteorological station and also a group of other instruments for the study of electric phenomena in the atmosphere: A radio receiver of 200 Mc for the recording of solar radio surges, a low frequency (40 Kc) direction finder for thunder discharges (spherics), and a radioactive cell for continual recording of the air's electric potential. Of course similar observations made by other scientific institutions will greatly help us complete our synthesis.

Next summer we shall also record the surface intensity of cosmic rays either with a vertical telescope equipped with three large Geiger tubes, or with a large ionization chamber.

A 40 Kw peak radar transmitter (3 cm. wave lenght) will help in lower atmosphere exploration. Incidently, the Superintendent of the Marine Division of the Canadian Marconi Co. very kindly assisted us in the installation and adjustment of this instrument.

The Defence Research Board has graciously provided us with another radar type transmitter, with which we are studying an unexplained but well established correlation between ionosphere reflexions and surface air masses. This correlation is found only when the transmitter pulsate vertically at a chosen fixed frequency. This frequency varies according to the geomagnetic latitude of different places. Here in Montreal we are transmitting at 4005 Kc: our geomagnetic position being

57°N, 356°E. Already in 1949, when in charge of the Central Meteorological and Seismological Observatory of Zikawei (Shanghai, China) we had found that such a correlation existed and were using it regularly in weather forecasting. However this correlation is found only when ionospheric echoes are obtained during daylight. Transmitting should be done after sunrise and before sunset, when the sun is directly acting on the ionosphere.

It is interesting to note that, transmitting on a frequency different from the chosen one by more than 500 Kc would fail to show any correlation useful for weather forecasting.

If results are as successful as those obtained in China, a new and very simple tool for weather forecasting will be established.

Using the same crystal controlled transmitter we will attempt to get reflexions from the discontinuities found in the troposphere, and possibly from the jet stream and the tropopause.

It is our conviction that such a global analysis of air masses, of their fronts and of their superimposed horizontal glidings, will help us achieve a better understanding of weather evolutions and will also be a step towards better weather forecasting.

We are quite aware that some of our research procedures are debatable. Someone will probably think that we are led much more by imagination than by mathematical considerations since a correlation is not a physical explanation. But without denying the necessity of these, we have learned that imagination is also very useful, especially when, according to former experience, we have found that mathematical objections raised against some of our attempts were found later on to be without foundation.

The future will show if our hopes were justified and if they provide the meteorologist with new lines of approach for solving the enigma of the earth's atmospheric circulation and of its behaviour.

Ernest Gherzi, S.J.,
Director for Research.

NOTE ON THE FORMATION OF THE WESTERLY JET STREAM IN THE NORTHERN HEMISPHERE.

The existence of a Westerly jet stream all around the earth's hemispheres, is usually explained as being due to thermodynamic factors and to the action of the polar-front displacement. However that may be, the cause of the distribution in space of these localized steep temperature and pressure gradients, as well as the irregular movements of the polar front, is not yet known.

We think that the formation of these gradients which cause the strong winds and the Southward motion of the polar-front, is chiefly due to a purely dynamic factor, to be found in the rotational force of the atmosphere which is continuously striving to keep in equilibrium the latitudinal distribution of its mass.

According to the documentation at our disposal, an important fact would seem to have been overlooked by the meteorologists who have studied the vagaries of the Westerly jet stream; whence these lines.

If we consider the pressure-altitudes given for the Standard Atmosphere, we find that the standard pressure-altitude for 500mb is around 18,200 ft; for 300mb, 30,000 ft; for 200mb, 38,600 ft; and for 100mb, a level not yet so well known, around 53,000 grft.

The analysis of hundreds of "Historical weather maps" of the Washington Weather Bureau, for the 500mb level, and others for the 300mb level, shows at once that this Westerly jet stream is usually "axed" on these standard heights, or close to them, usually to the south. And one should remember, when checking our statement, that surely the location of these level lines is accurate only within 200 ft.

To find out if there is a Westerly jet stream actually flowing, it is sufficient to follow the trend of these standard heights, namely the 18,200 ft for the 500mb level, the 30,000 ft for the 300mb level, etc.

This correlation is surely very striking and seems to point to the reason, not only of the existence of the Westerly jet stream, but also of its well-known displacement towards the pole during the summer, and towards the equator during the winter.

It is common knowledge that in the atmospheric layers, below the non-divergent surface of the 600mb level, the cold and warm air masses are irregularly located over the surface of the earth, disturbing in that way the equilibrium distribution of mass in the rotating atmosphere.

We believe that the rotational force of the atmosphere will tend to build up, so to speak, a "compression ripple" from the surface (low level jet) to the higher levels (500-100mb), vanishing into the stratosphere, which will distribute an equal amount of atmospheric mass north and south of the standard pressure altitude levels; these masses will contract towards the pole and expand towards the equator. This kind of horizontal "ripple" will tend to trace a varying course: inclining towards the pole when the southern portion of the rotating atmosphere has become warmer and lighter (summer), and towards the equator when it has become colder and denser (winter).

Over the continents, owing to the surface friction and viscous stresses, the course will be at times erratic, and will spread out in latitude, while over the large and homogeneous expanses of the Pacific Ocean it will run almost parallel to the latitudes. In the interpretation of the zigzagging flow of the jet over the continents, one should remember that the real atmospheric mass distribution over the mountains or the high plateaus is not the one shown by our weather charts, which use pressure values reduced to sea-level.

One can then understand why the pressure and temperature gradients are so steep along these lines, which show the standard heights of the pressure levels considered (500-100mb), and why the polar-front can reach southern latitudes of our hemisphere.

The momentary breaking up and even doubling of the jet stream ring will appear to be the consequence of a transient lack of equilibrium to be quickly restored.

Another fact can help to confirm our conception of the Westerly jet stream.

The same analysis of hundreds of weather charts at the 500mb level has shown that the geographical seasonal location of the 18,200 ft level has a direct correlation with the temperature observed on the surface region just below that level.

If this "compression ripple" in its poleward displacement passed over a surface region earlier in the season than expected according to the normal time schedule (1), the temperature in that region was warmer than usual; and contrariwise, if the arrival was behind time, the temperature was colder than normal. Similarly, if, in its equatorward displacement, the 18,200 ft line passed over a surface region later than expected, the weather was warmer than usual; it was colder, if the arrival happened too soon. Data from the Southern Hemisphere are too scanty to attempt a similar check for those regions.

The reported presence of an Easterly jet stream, in July, over the Subtropical regions of the Northern hemisphere, does not seem to contradict our statement. Anyhow its transient existence cannot compare with the continuity of the Westerly jet stream we have considered. More observations are still required before attempting to explain this Easterly jet also as a horizontal compression in the rotating atmosphere.

The same remark applies, we think, to the description of a round-the-pole, rather regular Westerly jet stream, discussed by Dr. F. Defant (2). A double "horizontal compression ripple" could perhaps be admitted according to our dynamic interpretation.

Fr. E. Gherzi S.J.

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(1) Cf. Normal weather charts for the Northern hemisphere. Sea level pressure; 700mb height and temperature; thickness (700-1000mb); 500mb Height. U.S. Department of Commerce. Weather Bureau. Washington D.C. October 1952.

(2) Cf. Berichte des Deutschen Wetterdienstes. NO. 22. Die meteorologische Tatung in Frankfurt a.M. von 17 bis 19 Oktober 1955. "Über die Struktur hochtropospärischer Düsenströme etc." by Friedrich Defant. p. 22/ 126.

GEOPHYSICAL RESULTS OBTAINED AT THE MACAU OBSERVATORY (1)

SE Asia; Lat. N. 22°.11'.45" (1950-1954)
Long. E. 113°.32'.39".)

The purpose of this article is to summarize the few geophysical results obtained at our recently installed geophysical section.

The local climatic, economic and social conditions, added to the impossibility of securing absolute measurement instruments, listed as "strategic", have made the work rather discouraging.

Since similar observations had never been made in past years in this part of the world (S.E. China, Philippines (?), Indonesia, Indochina and Burma) their relative values can be found useful to international science, as a very modest first approximation.

1°) IONOSPHERE AND SURFACE WEATHER

We have continued the experiences already started in 1939 at the Zikawei Observatory (Shanghai). In "Nature" (Feb. 1950) and elsewhere we have described our method.

Pulsing at 6 Mc/s which is the mean critical frequency of the E layer in Shanghai with a 100 watts radiated peak power, on a half wave aerial, 1/4 wave above the ground, during the daylight hours, **after** the local sunrise and **before** the local sunset, we have found a mysterious correlation between the type of echo received, any day of any month, and the type of the three main air masses, Polar, Maritime and Tropical (Equatorial of some meteorologists), which will make the surface weather for at least the next 12 hours. - Pulsing on another frequency (f.i. 3 or 8 Mc) gave erratic results. The same failure occurred when using the critical frequency of the F layers.

(1) We hope that these unpublished results may be found interesting even in North America. - Geophysical data collected at Brébeuf College in Montreal are still too scanty for any local research publication.

The E (100-150 km virtual vertical height) echo is correlated with the Maritime Pacific Air Mass. Usually the virtual vertical height is 120 km (Es ?). The F low echo(220-300 km)with the Polar air (Siberian in China). The F high echo(300-600 km)with the Tropical air from Indo-China and Burma.

As we have no continuous ionospheric registration on different frequencies, we cannot state if low level F or high level F should be reported as F_1 or F_2. We have found the Macau region very interesting for such an ionospheric method of checking the present surface weather and, forecasting the future.

At Zikawei we were able to check very accurately with the Polar (Siberian) air or the Maritime air (Pacific Ocean air mass). The Tropical air did not make the surface weather as often. In Macau the Siberian, the Maritime and especially the Tropical are very often the acting surface air masses. We insist on the surface quality of this correlation, as the radiosonde data at hand were too scanty for extending the use of our ionospheric weather method to upper levels. Other observatories provided with better radio-soundings could experiment and report their results afterwards.

In the Macau region, the action of the Tropical air invasions and the interaction of this type of air mass with the maritime air mass reaching our shores, were strikingly in accord with the different types of ionospheric echoes. F from a high level echoing layer was steady for days, as long as the weather map, drawn at 00.00 GMT, (the best time of the day we believe for a discriminative weather map in the Far East) would show tropical air well established over Southern China.

When a front developped between the Tropical air mass and the Maritime air mass, we obtained two different echoes, E and high F, sometimes both visible on the screen, sometimes succeeding one another. Curiously enough heavy thunder showers could then be forecasted, while with only a steady high F, correlated to prevailing Tropical air, showers would not be as heavy and not thundery. The intensity of the different we could probably reject the frontal effect. (1)

The high mountains of the Kowloon district, of the Hongkong Colony, sometimes gave easterly bearings. The NW bearing was obtained only when a visible thundery area was passing to the N W of Macau.

In doubtful cases, when the minimum value with the "sense" on, was rather indefinite, we read it by means of a sensitive voltmeter at the output. Typhoon weather conditions, as already established even by ourselves (2) and other researchers, did not increase the quantity of statics.

In winter, thundery spherics are almost non existent during daylight hours.

Bearings were taken also on the Hongkong air field radio beacons KT, 330 Kc. 3 Kw., WL 330 Kc., 250 watts and CC, 360 watts, all within two degrees,the limit of our instrument's reliability. The intensity of WL (250 watts) has been regularly found to be stronger than expected, when compared with the 3 Kw of K.T. radio bearing. As we were receiving the ground wave, orographic conditions would explain this phenomenon; the WL radiation not being as strongly affected by the big Nantao island as KT itself.

The CC radio beacon, nearer to us, and not obstructed by big islands, showed many fluctuations.

(1) Anyhow we quite agree with the statement published in the "Joint Commission on Radio Meteorology" - Proceedings of the second meeting held in Brussels, from August 16th to 18th, 1951, very kindly communicated to us by Col. E. Herbays, Secretary General of the U.R.S.I. - "Compte tenu de l'imprécision des «Spherics» les sources se situent, dans une forte proportion sur les limites des masses d'air. (p. 50).

Already in 1923 at the Zikawei Observatory (Shanghai - China), we were following with a revolving loop, tuned on 4000m, the southward advance of the cold front of the Siberian air mass invading N. China and pushing back the Tropical air covering S. China. Most of these spherics were of the «grinder type», rarely of the «crash or thundery type» (Cf. Revues Mensuelles de l'observatoire de Zikawei: 1922 et 1923).

(2) Cf.- Our articles in "Onde électrique" - 1925 - Paris.

All these radio beacons are out of sight from our observation station, (65 m above sea level). A few bearings were taken and intensity measurements were made also on the Manila "Rosario" radio beacon (RS) on 285 Kc. (power not listed). Since the prevailing statics (spherics) were found also along this SE bearing, we dare not give intensity figures.

Nevertheless the Manila radio beacon showed a variation of intensity, according to the different disposition of the air masses. When Macau and Manila were in the same type of air mass the intensity was rather steady, while in different situations, for instance with a front between the tropical air mass and the trade air mass (over the Philippines), the intensity was less than in the former situation. Nevertheless the word "Rosario", issued at regular intervals, was received without any distortion in both cases. We wonder if during our observations taken in daylight hours the ground wave was the only one received here in Macau. The distance from Macau to Manila is of the order of 600 nautical miles.

Research findings on the intermodulation produced by two carriers of the same frequency are well known to the readers of our article. We have tried to check the modulation decrease caused by this interaction but failed, owing to our poor oscillographic equipment. Instead, we have tried to examine the interference produced by the simultaneous arrival of the ground wave and the sky wave in the broadcasting band for stations of Manila, China and Japan.

The distant stations of China and those of Japan (over 1000 km distance) have shown only usual frequency distorsion and selective fading. For the Manila stations, not as distant as the Japanese stations, while the intensity was not showing any fading, from time to time voices and music started to "flutter" at a rather slow frequency.

This vibrating effect seems to be due to the interaction of the sky wave with the ground wave which is just arriving intermittently. As a matter of fact, later in the evening (10 p.m. local time), the Manila stations came in steady, without any vibration. A similar experience was noticed with the Hongkong low power broadcasting station. The technical director of this station, when asked about any variation or failure in their modulation, answered that they had not noticed nor registered anything like it in the operation of their station for the days and hours that we reported.

Evidently, a check was made to see whether or not certain stations quite close one to the other on that frequency band, were not present when we examine the different behaviour of the Manila Broadcasting station. These very close stations could have been the cause of the fluttering.

An internal aerial was used (Half wave dipole) and the radio receiver was a 5 valves superhetherodyne built by Philips and Co.(Holland).

The study of the manner a ground wave can and does reach a distant place, as does the first wave of the ocean tide on our coast, seems to have been neglected. The effect is of the «all or nothing» type, without any real fading, contrary to what happens for the oscillations received via the ionosphere.

RADAR RESEARCH ON TROPOSPHERIC AND STRATOSPHERIC ECHOES

By means of a British radar transmitter, type 291 (210 Mc. and 100 Kw peak power), we have undertaken long hours of research for tropospheric echoes. Many times we noticed a fluctuating type of reflexion at about a virtual height of 20 to 25 km. Although the constants of our instrument were kept the same, these reflexions were not always present. We thought that these echoes could possibly come from the ozone layer, but finally remained rather sceptic since they had never been reported from other radar research teams.

Nevertheless our experiment could possibly be relevant if we would compare our results with the following quotations from a recent article by Mr. M.V. Mironovitch in the "Annales de Géophysique" (tome 9, N° 4, 1953. Paris, Centre National de la recherche scientifique. "Essai d'une coupe aérologique verticale, p. 289.

"Le trait le plus caractéristique de nos diagrammes est sans doute le changement de structure thermique de la stratosphère entre les niveaux de 100 et 40 mb. C'est l'absorption de l'énergie solaire par l'ozone de ces couches qui en est responsable. A partir de cet étage stratosphérique et plus haut, la géométéorologie est sous l'influence directe de l'hélio-météorologie. On sait maintenant que la variabilité de température et de pression entre 20 et 30 km peut devenir très grande. En effet Scherhag, en étudiant une année de radio-sondages, poussés à 30 km au moins (Berlin), a pu constater plusieurs cas de réchauffement intense et rapide des couches stratosphériques entre 30 et 20 km; dans certains cas ce réchauffement des couches stratosphériques atteignait 30° à 40° en 48 heures et pouvait être relié à des phénomènes violents solaires. Ces perturbations stratosphériques présentent donc une réalité".

The explanation of our echoes would be found in the following quotation from the same article. (pag. 287).

"Un espace étroit, au dessus de l'équateur, est caractérisé par des vents d'Est qui sont nettement décalés vers l'hémisphère estival, aussi bien dans la troposphère que dans la basse stratosphère. Ces vents équatoriaux d'Est manifestent plusieurs foyers de vitesse maxima, dont les plus permanents sont localisés entre 11 et 13 km d'altitude. Un autre «jet» de courant fort d'Est se dessine dans la stratosphère estivale vers 21 km; il est très étendu en latitude et s'étend certainement bien au dessus de 22 km".

We have quoted at lenght since the author's statements may have been misunderstood by shorter excerpts. In any event, it may be a very simple and useful means of locating atmospheric «jet streams» by radar if our results are not due to the rather unexpected «misfortune» of getting spurious echoes just from these interesting levels (21 km).

Several years ago we printed in the Bulletin of the American Met. Society a short article about similar results obtained at the Zikawei Observatory where several radar experts had come to examine our equipment.

As no reaction to our ideas were found in the usual Meteorological reviews, we did not insist. Today other radar centres could possibly try to use the same frequency of 210 Mc. or just about, and check our findings.

Concerning the «Jet stream» at a level lower than 11 km we must state that here in Macau topographic location prevented any serious check. The side lobes of our radar beam were reflected by the island and masked any possible tropospheric echo from below the 11 km level.

During our work at Zikawei Observatory until 1949, at times we obtained these reflexions from 10 to 14 km on a lower frequency (20 Mc.). Air pilots in the United States when flying at these levels had several times reported a kind of foggy sheet. The explanation was given by the Meteorologists of the Chicago Meteorological Institute when they devised a new radio-sonde psychrometer useful up to 20 km.

4°) ULTRA SHORT WAVE PROPAGATION

By means of a very sensitive radar receiver, built during the last war by the Western Electric for the U.S.A. Signal Corps (BC. 406 type) we were able to undertake, during the last 10 months, relative intensity measures on the Canton air Field radio beacon DX, radiating on the 210 Mc band. As we had no receiver for the 100 Mc. band it is not impossible that we had been receiving the second harmonic, since the 100 Mc. band and not the 200 Mc. band is usually employed at the air fields. Nobody in Hongkong (H.M. Navy or USA air force) has been able to answer our querries about this radio beacon.

Our receiver was equipped with 2 acorn tubes in H.F. stages, one acorn oscillator, one acorn oscillator amplifier, one acorn mixer, 5 Pentode I.F. (20 Mc.) one Pentode plate detector and one Video high voltage gain. Its sensitivity appeared to be better than 1 microvolt over 75 ohms.

Canton is about 220 km to the NE of Macau, well out of sight from our station. Moderately high hills (200 m to possibly 300 m) lie between.

The intensity of the call signals, received on an interior dipole have been quite readable during more than 90% of the listening (readings varying between 2 and 4 on the usual scale of 5). The output meter (4000 ohms for 1 volt A.C.) gave 0.1 to 0.2 R.M.S. volts and 35 to 50 or 60 microamperes. The hours of listening were from 8 a.m. to 4 p.m. local zone (120° E) time. The station closed down at 4 p.m. with a long dash, making it possible to take a radio bearing. The silent bearing was quite sharp on the NE to SW line. A perceptible increase of intensity was often noticeable around noon. Sometimes, at odd moments during the day, when the reception was strong, one could hear another radio beacon on the same frequency with a higher pitch of modulation. We were not able to locate this radio beacon nor to take a reliable bearing on it. With a dry and cold Polar (Siberian) surface air mass the intensity was smaller than with tropical surface air. The temperature and specially the humidity of the air seem to be the predominant factors for long distance propagation of ultra short radio-waves.

Typhoon or thundery local weather conditions did not affect the intensity of reception.

Concerning the reception of these signals from the Canton air field radio beacon (around 230 km distant) it is interesting to quote a few lines from Dr. R.L. Smith-Rose (Wave propagation with particular reference to television, p. 275 - Proceedings of the Institution of Electrical Engineers. Vol. 99 No. 18 1952).

"The lenghts of the transmission paths investigated varied from 110 to 270 km, and the rate of fading increased with distance as might have been expected; a diurnal variation was found on all links. Although much more detailed knowledge of the prevailing meteorological conditions would have been desirable, it was possible to show that, over path of 110 km (on 90 Mc) and 160 km. (on 45 Mc.) the strongest signals were almost certainly caused by reflection at elevated inversion layers. It seemed reasonably certain, however, that atmospheric scattering was not important over any of the paths investigated".

Our experience with the Canton airfield radio beacon seems to consignal. The wind rose to 120 km per hour. Then, as an F echo from about 260 km appeared, we lowered all typhoon signals, Hongkong hoisted No 9 signal, meaning increasing intensity of the gale. We had only 50 km per hour winds, when the centre passed close to us in the South.

5) On the 24th of November 1950, a typhoon having struck the Eastern tip mountains of Hainan Island, recurved sharply North-Eastward and landed, closeby, to the West of Macau. We received a persistent F echo from 250 km. We did not hoist the black cross hurricane signal; but the black ball signal for high winds and rain. The wind's highest gust reached only 72 km per hour. Had we received an E echo we would have at once forecasted hurricane gales (black cross International hurricane signal).

6) On the 22nd of August 1951, a typhoon had been located to the East of Shanghai. The Guam Weather Central forecasted a NW movement. We had a strong F echo from 250 km, showing that, according to our experience, China was under the Siberian air mass. We rejected the U.S. Navy (or Air Force) prediction. The following day the typhoon was over Eastern Korea, having recurved North-Eastward. Such mistake from Guam might have been very dangerous for ships sailing from Shimonoseki down to the Eastern Sea.

7) On August 1951, a typhoon entered the Southern part of the Formosa Strait. The Hongkong Observatory, the following day located it at Lat. 24°N. moving North-Eastward. We received an E echo and reported that the typhoon was stationary. The centre did not pass up the Strait, but even came, the following day, nearer to Hongkong and Macau, moving South-Westward, while raising high winds in Hongkong.

8) On September 18th 1951, a typhoon had reached the Northern tip of Luzon (Philippine Islands) moving West-North-Westward. Guam Weather Central forecasted that the following day the typhoon would be in Lat. 23° N. and Long. 123° E, having moved North by West. We received an E echo and forecasted that the typhoon would keep moving West-North-Westward. The following day it was located near Pratas Island

(Lat. 20° 50' N, Long. 117° E.) This wrong Guam forecast could have been very dangerous for South-bound ships in the Formosa Strait and for Hongkong-Manila shipping.

9) On the 25th of September 1951, a typhoon, to the South-East of Pratas Island, was reported by Hongkong as moving slowly West-North-Westward. We received an E echo and then an F echo from about 260km. A warning was given to the Portuguese troopship "India", then in Hongkong, that she was not to leave for Singapore on that day, as intended, but should wait until the following afternoon. The typhoon recurved sharply North-Eastward. Had the ship trusted the signal hoisted in Hongkong she would have sailed right into the storm. Later that day, the Hongkong Observatory signaled the typhoon on the North-East track. Our warning had been about twelve hours earlier than that of Hongkong.

10) On October 19th 1951, a small typhoon formed over the Paracels Reefs. It started Northward and might have gone North-Eastward as some of these typhoons do, to strike the region of Macau afterwards. We received an F echo from about 260 km and did not hoist any signal. Nothing happened to Macau and the typhoon went into the Tongking Gulf.

This list could be extended, going back to the last ten years out of the thirty spent at the ZiKaWei Observatory (Shanghai-China) in weather service. We will quote only one more case which remains famous. In October 1945, a typhoon to the SE of Ishigakijima was reported by the U.S. Navy, as moving West-North-Westward and as due to strike Northern Formosa. We had received an F echo and told the Navy officer who had come to see us that the typhoon had recurved North-Eastward and that he should immediately warn Okinawa Station. Our advice was not followed until six hours later when the 6:00 p.m. weather reports had been received and when it was found that our report was correct. A warning was sent out but it was too late. Over 100 (sic) medium and small size ships were wrecked or beached at Okinawa.

We insist in stating that the exactness of our forecasts was not due as much to long experience in weather forecasting as to reliance placed on the ionospheric echoes received. In all cases listed the weather reports at hand may not have been sufficient to make a good forecast, and that may have been the reason why others erred."

(Cf. Provincia de Macau. Servico Meteorologico. Notas Cientificas. No 3. "A ionosfera e o tempo" pelo Pe. E. Gherzi, S.J. Macau. Imprensa Nacional 1952).

RADIATION SOLAIRE

Radiation solaire globale en calories, par cm^2, par jour, directe et diffuse, reçue sur une surface horizontale. Aussi, moyenne par mois.

	Avril	Mai	Juin	Juillet	
1		640	253	446	1
2		455	602	M	2
3		272	472	699	3
4		196	429	672	4
5		605	266	543	5
6		530	685	178	6
7		587	584	332	7
8		641	369	279*	8
9		430	204	460	9
10	461	535	M	475	10
11	510	512	648*	547	11
12	523	407	650	615	12
13	231	501	594	404	13
14	396	172	597	411	14
15	143	605	563	657	15
16	M	161	532	701	16
17	316	650	670*	516	17
18	314	534	630*	567	18
19	273	187	M	609	19
20	503	622	528	640	20
21	418	512	312	231	21
22	206	523	622	362	22
23	446	492	428	415	23
24	461	574	575	492	24
25	590	589	586	536	25
26	209	479	705	725	26
27	477	75	301	571	27
28	220	371	M	422	28
29	218	602	446	464	29
30	508	130	165	378	30
31		308		567	31
MOYENNE	371	448	479	482	

M : Enregistrement manqué

* : Valeur approximative, appréciée partiellement

	Août	Septembre	Octobre	Novembre	Décembre	
1	543	M	167	88	90	1
2	598	327	207	79	277	2
3	545	551	415	119	130	3
4	530	466	270	220	253	4
5	539	466	466	191	138*	5
6	558	237	422	189	26	6
7	497	505	226	187	66	7
8	594	415	451	99	97	8
9	455	484	296	114	110	9
10	378	393	334	296	156	10
11	565	42	439	167	83	11
12	543	294	367	130	141	12
13	464	367	215	180	127	13
14	499	308	356	244	112	14
15	638	266	338	68	79	15
16	584	101	228	22	90	16
17	549	202	303	169	35	17
18	395	462	384	147	M	18
19	404	464	340	242	M	19
20	649	308	345	152	M	20
21	508	296	125	M	134	21
22	401	505	381	204	M	22
23	279	268	229	174	39	23
24	386	121	382	279	26	24
25	565	288	380	231	191	25
26	264	494	360	37	167	26
27	554	475	33	66	89	27
28	505	451	218	152	79	28
29	446	M	178	44	53	29
30	134	341	310	242	272	30
31	156		209		152	31
MOYENNE	474	353	302	156	119	

NOTE: Ces valeurs sont probablement un peu trop élevées à cause des radiations réfléchies par l'abri des thermomètres sur le solarigraphe. La distance est moins de 30 pouces. Nous changerons l'appareil de place pour éviter ces erreurs.

BULLETIN SISMOLOGIQUE

OBSERVATOIRE

LONGITUDE: 73° 37' 26" OUEST

LATITUDE: 45° 30' 09" NORD

ALTITUDE : 112 m.

FONDATION : CALCAIRE ORDOVICIEN (TRENTON LIMESTONE).

INSTRUMENTS

SISMOGRAPHES BENIOFF ENZ 100 Kg.

	To	Tg	Amplification	Amortissement	Vitesse du papier
Z	1.0	0.2	38,000	critique	60 mm
E	1.0	75		critique	60 mm
N	1.0	75		critique	60 mm

Un départ du tracé vers le haut indique que la terre va:

pour E vers l'EST

pour N vers le SUD

pour Z vers le bas : Dilatation

mais après le 1er février 1957, ce sera le contraire pour N et Z.

A l'heure actuelle, seule l'amplification de Z a été déterminée, et pour des oscillations de la terre de 1 seconde de période.

Le Temps indiqué est toujours "G.M.T."

Le 29 novembre, le galvanomètre E 75 secondes est changé pour un de 20 secondes temporairement.

L'enregistrement de l'heure est obtenu au moyen d'un chronomètre de marine à contact électrique de Thomas Mercer, dont les variations de marche dépassent rarement 0.2 secondes par jour. De plus, le signal horaire de l'Observatoire du Dominion relayé par le poste local de radio CBF à 1:00 p.m. s'enregistre automatiquement sur tous les sismogrammes.

M. Buist, S.J., directeur.

AVRIL A FIN DECEMBRE 1956

12 avril

U.S.C.G.S.
22 S 72½ W
Off Coast N. Chile
H: 05 05 37

Brébeuf
iP 05 16 23 d
i 05 16 39
i 05 16 46
i 05 16 54

22 avril

U.S.C.G.S.
24 N 162 W
South Alaska
H: 17 21 53

Brébeuf
eP 17 31 22

23 avril

U.S.C.G.S.
42½ N 144½ E
Off Coast of Hokkaido
H: 03 31 40

Brébeuf
iP 03 44 18 c
e 03 44 20
e 03 44 31
e 03 44 53

28 avril

Brébeuf
eP 07 04 57
07 05 00
07 05 27

1 mai

U.S.C.G.S.
Banda Sea 150 miles
N-E of Timor Isl.
H: 02 45 16

Brébeuf
iP´ 03 01 26
i 03 01 31
e 03 04 25
i 03 04 39

6 mai

U.S.C.G.S.
54 N 162½ W
Unimak Island, Alaska
H: 20 57 16

Brébeuf
eP 21 06 45
21 06 48
21 07 10

7 mai

U.S.C.G.S.
14½ N 90½ W
Guatemala
H: 08 17 03
h: about 200 Km

Brébeuf
iP 08 23 34 c
i 08 23 37
i 08 24 55

15 mai

U.S.C.G.S.
13½ S 77 W
Near Coast of Peru
H: 08 13 02
h: about 100 Km

Brébeuf
iP 08 22 55 c

15 mai

U.S.C.G.S.
6 S 82 W
Near Coast of Peru
H: 12 32 59

Brébeuf
eP 12 42 23

17 mai

U.S.C.G.S.
16½ S 72 W
Near Coast of Peru
H: 05 59 57
h: about 60 Km.

Brébeuf
iP 06 10 16 c

21 mai

U.S.C.G.S.
N.Chile
H: 00 29 47
h: about 100 Km

Brébeuf
iP 00 40 21 c
i 00 40 48

22 mai

U.S.C.G.S.
4 S 152½ E
New Ireland
H: 13 36 12
h: about 550 Km

Brébeuf
iP´ 13 54 13 d

26 mai

Brébeuf
iP 00 44 17.5 c
Faible secousse locale.
Roulement souterrain entendu
mais non senti.

26 mai

U.S.C.G.S.
19 S 178½ W
Fiji Islands
H: 20 21 14
h: about 550 Km

Brébeuf
eP´ 20 38 56

3 juin

U.S.C.G.S.
79½ N 118½ W
Arctic Ocean
H: 05 19 23

Brébeuf
iP 05 26 42 d

4 juin

U.S.C.G.S.
52 N 170½ W
Fox Isl. Aleutians
H: 07 09 18

Brébeuf
eP 07 19 24

5 juin

Brébeuf
eP_n 07 51 17

8 juin

U.S.C.G.S.
30 S 70 W
Argentina-Chile border
H: 13 53 09
h: about 150 Km

Brébeuf
eP 14 04 42

9 juin

U.S.C.G.S.
35½ N 67½ E
Afghanistan
H: 23 13 51

Brébeuf
iP 23 27 05 c
PP 23 30 17
PPP 23 32 55
L 23 40 00
M 24 09 40

11 juin

U.S.C.G.S.
34½ N 26½ E
Near S. coast of Crete
H: 01 11 24

Brébeuf
iP 01 22 56

11 juin

U.S.C.G.S.
52 N 31½ W
N.Atlantic
H: 08 22 09

Brébeuf
iP 08 28 00 d

11 juin

U.S.C.G.S.
27½ S 69 W
N. Chile - Argentina border
H: 09 56 10

Brébeuf
iP 10 07 45 d
i 10 08 11

11 juin

U.S.C.G.S.
Near Coast of N. Peru
H: 22 33 51

Brébeuf
iP 22 43 22 c

12 juin

U.S.C.G.S.
9 S 110 W
E. Pacific Ocean
H: 08 52 02

Brébeuf
iP 09 04 35 d

14 juin

U.S.C.G.S.
45 N 150½ E
Kurile Islands
H: 12 12 19

Brébeuf
iP 12 24 40 c
i 12 26 02

15 juin

Brébeuf △ about 300 Km
eP_n 00 54 15
iS_n 00 54 51

22 juin

U.S.C.G.S.
S.Peru
H: 23 35 56
h: about 100 Km

Brébeuf
iP 23 46 11 c
i 23 46 42

23 juin

U.S.C.G.S.
56½ N 163½ E
Near Coast of Kamchatka
H: 02 18 02

Brébeuf
iP 02 29 02 d
i 02 58 25
L 03 02 18

3 juillet

U.S.C.G.S.
13½ N 91 W
Near Coast of Guatemala
H: 15 46 41

Brébeuf
eP 15 23 34

4 juillet

U.S.C.G.S.
31 S 71 W
Central Chile Felt
H: 11 08 28

Brébeuf
iP 11 20 21
i 11 20 37

6 juillet

U.S.C.G.S.
42½ N 126 W
Off Coast of Oregon
H: 02 22 00

Brébeuf
eP 02 29 16

9 juillet

U.S.C.G.S.
37 N 26 E
Aegean Sea 42 killed
H: 03 11 39

Brébeuf
iP 03 22 59 d
iPP 03 25 32
S 03 32 23
SS 03 37 08

9 juillet

U.S.C.G.S.
Aegean Sea aftershocks
H: 03 24 05
H: 06 19 07

Brébeuf
iP 03 35 22 c
iP 06 34 06 c

9 juillet

U.S.C.G.S.
20 N 73 W
Near Coast of Haiti
H: 09 56 13
h: about 100 Km

Brébeuf
iP 10 01 39 c
iS 10 06 20
isS 10 06 47
i 10 07 04

10 juillet

U.S.C.G.S.
Aegean aftershock
H: 03 01 27

Brébeuf
iP 03 12 46 d

13 juillet

U.S.C.G.S.
27 S 70 W
N. Chile
H: 13 36 03
h: about 100 Km

Brébeuf
iP 13 47 23 c
i 13 47 44
i 13 47 52

16 juillet

U.S.C.G.S.
52½ N 161½ E
Near Coast of Kamchatka
H: 09 24 38

Brébeuf
eP 09 35 44 c

16 juillet
U.S.C.G.S.
23½ N 96 E
Central Burma 30 killed
H: 15 07 06
Brébeuf
eP´ 15 26 31
L 16 19 00

17 juillet
U.S.C.G.S.
7 S 126½ E
Banda Sea
H: 07 34 07
Brébeuf
iP´ 07 52 34 c
PcP 07 52 45
sP 07 54 32
PP 07 55 34
pPPP 07 58 38
M 08 02 30

19 juillet
U.S.C.G.S.
9½ N 84½ W
Near Coast of Costa Rica
H: 23 26 25
Brébeuf
iP 23 33 39

20 juillet
U.S.C.G.S.
20 S 70 W
N. Chile
H: 07 39 10
Brébeuf
iP 07 49 49 c
PcP 07 50 45

21 juillet
U.S.C.G.S.
1 N 26 W
Mid-Atlantic
H: 00 08 31
Brébeuf
eP 00 18 51

21 juillet
U.S.C.G.S.
50½ N 147½ E
Sea of Okhotsk
H: 14 51 06
h: about 600 Km
Brébeuf
iP 15 02 06 d

22 juillet
U.S.C.G.S.
Aegean aftershock
H: 03 28 59
Brébeuf
iP 03 40 21 c

22 juillet
U.S.C.G.S.
19 S 69 W
N. Chile
H: 09 25 08
h: about 100 Km
Brébeuf
iP 09 35 39 d
pP 09 35 53
PcP 09 35 59
sP 09 36 05
S 09 44 09

23 juillet
U.S.C.G.S.
24 S 102 W
Easter Island
H: 19 25 58
Brébeuf
eP 19 38 00
i 19 38 10

24 juillet
U.S.C.G.S.
1 N 126½ E
Mohicca Passage
H: 18 56 32
Brébeuf
eP´ 19 15 49

26 juillet
U.S.C.G.S.
23 S 69 W
N. Chile
H: 08 30 24
Brébeuf
iP 08 41 28 d
i 08 41 39

27 juillet
Brébeuf △ about 80 Km
iP_n 01 34 58.2 c
S_i 01 35 09
S_n 01 35 12

30 juillet
U.S.C.G.S.
Aegean aftershocks
H: 09 15 00
H: 10 39 56
Brébeuf
iP 09 26 21 d
i 09 32 42
iP 10 51 18

1 août
U.S.C.G.S.
28½ S 71½ W
Central Chile foreshock
H: 06 44 00
Brébeuf
iP 06 55 39 c

1 août
U.S.C.G.S.
28½ S 71½ W
Central Chile
H: 06 57 09
Brébeuf
iP 07 08 47 c

1 août
U.S.C.G.S
18½ N 71 W
Dominican Republic
H: 20 28 26
Brébeuf
iP 20 34 10 c

2 août
U.S.C.G.S.
5½ N 75½ W
Central Columbia
H: 07 11 20
h: about 200 Km
Brébeuf
iP 07 18 48 c

2 août
U.S.C.G.S.
43 N 146½ E
Off Coast of Hokkaido Japan
H: 07 18 11
Brébeuf
iP 07 30 44 c

12 août
U.S.C.G.S.
51½ N 175½ E
Aleutian Islands
H: Aug 11 23 54 16
h: about 100 Km
Brébeuf
iP 00 00 31 c

12 août
U.S.C.G.S.
34½ N 138 E
Near Coast of Honshu Japan
H: 16 59 33
Brébeuf
iP 17 13 04 c

15 août
U.S.C.G.S.
O , 101½ E
Sumatra
H: 05 20 37
h: about 300 Km
Brébeuf
iP´ 05 42 24 .

15 août
U.S.C.G.S.
½ S 123 E
N. Celebes
H: 10 51 19
h: about 150 Km
Brébeuf
iP´ 11 09 54 d

15 août
U.S.C.G.S.
43½ N 16½ E
Near Coast of Yogoslavia
H: 12 02 54
Brébeuf
eP 12 13 05

15 août
U.S.C.G.S.
46½ N 151 E
Kurile Islands
H: 13 12 10
Brébeuf
iP 13 24 27 c

16 août
U.S.C.G.S.
37½ N 8½ W
Near S.coast of Portugal
H: 02 09 39
Brébeuf
iP 02 18 21 c

20 août
U.S.C.G.S.
7½ N 80 W
Near S.coast of Panama
H: 05 33 47
Brébeuf
iP 05 41 12 d

20 août
U.S.C.G.S.
Panama aftershock
H: 07 19 59
Brébeuf
iP 07 26 28 c

20 août
U.S.C.G.S.
13½ N 91½ W
Off coast of Guatemala
H: 09 43 50
Brébeuf
iP 09 50 43
i 09 51 07

Les sismographes ont été bloqués du 20 août au 20 septembre à cause de coups de mines à côté de la voûte.

20 septembre
U.S.C.G.S.
Near coast of N. Chile
H: 03 02 50
Brébeuf
eP 03 13 37

20 septembre
U.S.C.G.S.
51 N 159 E
Near S. coast of Kamchatka
H: 20 06 09
Brébeuf
iP 20 17 41 c

20 septembre
U.S.C.G.S.
51½ N 159½ E
Near S.coast of Kamchatka
H: 21 52 01
Brébeuf
iP 22 03 30 c

21 septembre
U.S.C.G.S.
26½ S 63 W
Santiago Argentina
H: 19 11 59
h: about 100 Km
Brébeuf
iP 19 22 32 d
i 19 29 34

21 septembre
U.S.C.G.S.
46 N 151½ E
Kurile Islands
H: 22 55 46
Brébeuf
iP 23 07 59 c

26 septembre
U.S.C.G.S.
52½ N 176 E
Rat Aleutians Islands
H: 13 46 52
h: about 100 Km
Brébeuf
iP 13 57 26 c
i 13 57 59

29 septembre
U.S.C.G.S.
35½ N 140 E
Central Honshu Japan
H: 23 20 52
h: about 60 Km
Brébeuf
iP´ 23 34 05 c

1 octobre
U.S.C.G.S.
18½ N 77 W
Jamaica
H: 18 04 40
Brébeuf
iP 18 10 29 c

2 octobre
U.S.C.G.S.
53 N 159 E
Kamchatka
H: 14 56 26
h: about 60 Km
Brébeuf
iP 15 07 45 c

2 octobre
U.S.C.G.S.
20 S 69½ W
Chile
H: 08 18 46
h: about 100 Km
Brébeuf
iP 08 29 17

4 octobre
U.S.C.G.S.
About 200 miles off coast
of Chiapas Mexico
H: 17 15 14
Brébeuf
iP 17 22 15 c

6 octobre

U.S.C.G.S.

About 100 miles off coast of Panama

H: 06 52 13

Brébeuf

eP 06 59 45

11 octobre

U.S.C.G.S.

46 N 150½ E

Kurile Islands

H: 02 24 33

h: about 100 Km

Brébeuf

iP 02 36 40 d

S_n 02 46 39

SS 02 52 03

SSS 02 55 32

11 octobre

U.S.C.G.S.

46½ N 126½ W

Off Cape Mendocino Cal.

H: 16 48 46

Brébeuf

iP 16 56 09 c

S 17 02 09

M 17 09 47

12 octobre

U.S.C.G.S.

15 S 74½ W

Near coast of Central Peru

H: 02 37 43

Brébeuf

iP 02 47 50 c

12 octobre

U.S.C.G.S.

42½ N 144½ E

Near coast of Hoccaido Japan

H: 12 22 48

Brébeuf

iP 12 35 28 d

13 octobre

U.S.C.G.S.

9½ N 70 W

Western Venezuela

H: 05 04 40

Brébeuf

eP 05 11 45

13 octobre

U.S.C.G.S.

49½ N 156 E

Northern Kurile Islands

H: 15 12 25

Brébeuf

iP 15 23 31 d

19 octobre

U.S.C.G.S.

52 N 177 E

Rat Island, Aleutians Isl.

H: 20 47 43

Brébeuf

iP 20 58 14 c

19 octobre

U.S.C.G.S.

11½ S 76 W

Central Peru

H: 01 28 53

h: about 100 Km

Brébeuf

iP 01 38 29 c

23 octobre

U.S.C.G.S.

Off Coast El Salvador

H: 04 24 52

Brébeuf

iP 04 31 32

23 octobre

U.S.C.G.S.

3 N 95 W

N-W of Galapagos Islands

H: 08 07 35

Brébeuf

iP 08 16 04

23 octobre

U.S.C.G.S.

13½ N 120½ E

Philippines

h: about 100 Km

H: 08 41 22

Brébeuf

iP´ 09 00 06

24 octobre

U.S.C.G.S.

12 N 87 W

Near Coast of Nicaragua

H: 14 42 11

Brébeuf

iP 14 49 11

iS 54 50

M 15 05 00

25 octobre

U.S.C.G.S.

12 N 87 W

Nicaragua aftershock

Brébeuf

iP 05 28 41 c

27 octobre

U.S.C.G.S.

12 N 86 W

Near coast of Nicaragua

h: about 200 Km

H: 15 33 08

Brébeuf

iP 15 39 50 c

28 octobre

U.S.C.G.S.

32 S 179 W

Kermadec Islands

H: 03 28 41

Brébeuf

iP´ 03 47 30 c

29 octobre

U.S.C.G.S.

8½ S 77 W

Central Peru

h: about 60 Km

H: 15 42 08

Brébeuf

iP 15 51 29 d

30 octobre

U.S.C.G.S.

5 N 79 W

Off coast of Columbia

H: 22 52 27

Brébeuf

iP 23 00 12 d

31 octobre

U.S.C.G.S.

5 N 79 W

Columbia

H: 00 03 04

Brébeuf

iP 00 10 47 d

31 octobre

U.S.C.G.S.

26½ N 54½ E

Southern Iran

H: 14 03 38

Brébeuf

iP 14 17 08 c

1 novembre

Brébeuf
iP 08 11 38 d
Nothing given by U.S.C.G.S.

4 novembre

U.S.C.G.S.
Southern Quebec Canada
Felt Gatineau
H: 11 53 30
Brébeuf △ 185 Km
iP_n 11 53 53.1 d
iS_n 11 54 13

4 novembre

U.S.C.G.S.
35½ N 140 E
Near coast of Honshu Japan
h: about 100 Km
H: 05 37 15
Brébeuf
iP 05 50 28 c

9 novembre

U.S.C.G.S.
17 N 94 W
Southern Mexico
Slight Damages
h: about 150 Km
H: 13 06 10
Brébeuf
iP 13 12 35
ipP 13 12 50
isP 13 13 10
iPP 13 13 45
isPP 13 14 02
iPcP 13 14 30
iS 13 17 45

11 novembre

U.S.C.G.S.
44 N 149 E
Kurile Islands
H: 19 15 20
Brébeuf
iP 19 27 48 d

15 novembre

U.S.C.G.S.
3 S 103 W
Pacific Ocean about 900miles west of Galapagos Islands
H: 17 27 55
Brébeuf
iP 17 37 33 c

16 novembre

Brébeuf △ 120 Km
iP 07 18 12.5 d
S 07 18 27

16 novembre

U.S.C.G.S.
8½ N 71 W
Northwestern Venezuela
H: 11 53 54
Brébeuf
iP 12 01 09 d

16 novembre

U.S.C.G.S.
18 S 69 W
Peru-Bolivia-Chile border
h: about 150 Km
H: 22 02 19
Brébeuf
iP 22 12 34 c

17 novembre

U.S.C.G.S.
54½ N 134 W
Queen Charlotte Islands
H: 20 27 15
Brébeuf
iP 20 34 42 c
PcP } 20 36 49
PPP }
S 20 41 43

20 novembre

U.S.C.G.S.
39½ N 25½ E
Aegean Sea
H: 23 20 52
Brébeuf
iP 23 32 06 c

21 novembre

U.S.C.G.S.
38 N 142 E
Near coast of Northern Honshu
h: about 60 Km
H: 07 33 28
Brébeuf
iP 07 46 28 d

23 novembre

U.S.C.G.S.
52½ N 169½ W
Fox Islands Aleutians
H: 10 00 50
Brébeuf
iP 10 10 45 c

24 novembre

U.S.C.G.S.
22½ S 67 W
Argentina-Bolivia border
h: about 150 Km
H: 01 56 06
Brébeuf
iP 02 06 58 d
i 02 07 29
i 02 07 47

25 novembre

U.S.C.G.S.
17 S 72 W
Near coast of S Peru
H: 14 14 57
H: 14 15 07
Brébeuf
iP 14 25 28 d
iP 14 25 41 d
i 14 25 48

25 novembre

U.S.C.G.S.
14½ S 168 E
New Hebrides Islands
H: 18 07 34
Brébeuf
eP 18 26 26

26 novembre

U.S.C.G.S.
26 S 70½ W
N.Chile
h: about 100 Km
H: 18 49 56
Brébeuf
iP 19 01 07 d
i 19 01 22

26 novembre

U.S.C.G.S.
22 S 169 E
Loyalty Islands
H: 23 29 41
Brébeuf
eP 23 48 40

28 novembre

U.S.C.G.S.
49½ N 155 E

N.Kurile Islands
H: 19 27 11
Brébeuf
iP 19 39 03 d

30 novembre
U.S.C.G.S.
31½ S 70 W
San Juan Province Argentina
h: about 150 Km
H: 19 30 34
Brébeuf
iP 19 42 13 c

1 décembre
U.S.C.G.S.
17½ S 72½ W
Off coast of S.Peru
H: 21 24 54
Brébeuf
iP 21 35 24 d

2 décembre
U.S.C.G.S.
52½ N 169 W
Fox Islands foreshock
H: 02 59 56
Brébeuf
iP 03 09 54 c

3 décembre
U.S.C.G.S.
53 N 169 W
Fox Islands foreshock
H: 07 12 44
Brébeuf
iP 07 22 49 c

3 décembre
U.S.C.G.S.
53½ N 169 W
Fox Island Aleutians
H: 07 20 08
Brébeuf
iP 07 30 03 c

3 décembre
U.S.C.G.S.
52½ N 169 W
Fox Island aftershock
H: 07 44 55
Brébeuf
iP 07 54 52 c

3 décembre
Brébeuf
iP 07 57 08 d

4 décembre
U.S.C.G.S.
50 N 156 E
Kurile Islands
H: 08 44 28
Brébeuf
iP 08 56 42 c

4 décembre
U.S.C.G.S.
53 N 169 W
Fox Islands aftershock
H: 10 42 10
Brébeuf
iP 10 52 07

4 décembre
U.S.C.G.S.
15 N 92 W
Guatemala
h: about 150 Km
H: 23 01 35
Brébeuf
iP 23 08 11 d
i 23 08 34
S 23 14 23

5 décembre
U.S.C.G.S.
Near coast of S.Peru
H: 01 47 56
Brébeuf
iP 01 58 22 c

8 décembre
U.S.C.G.S.
51 N 179½ W
Andreanof Island Aleutians
H: 16 10 27
Brébeuf
iP 16 21 01 c

9 décembre
U.S.C.G.S.
53 N 169 W
Fox Island aftershock
H: 05 19 06
Brébeuf
eP 05 30 03

9 décembre
U.S.C.G.S.
Off coast of Kamchatka
H: 17 00 45
Brébeuf
iP 17 12 13 c

10 décembre
U.S.C.G.S.
Argentina-Chile border
H: 23 15 00
Brébeuf
iP 23 26 11 d

13 décembre
U.S.C.G.S.
31 N 115 W
Lower California
H: 13 15 37
Brébeuf
iP 13 22 33 d

15 décembre
U.S.C.G.S.
about 300 miles north of Galapagos Islands
H: 09 03 30
Brébeuf
iP 09 11 38 c

16 décembre
U.S.C.G.S.
6½ N 78 W
Near coast of Columbia
H: 01 41 52
Brébeuf
iP 01 49 24 d
S 01 55 19

18 décembre
U.S.C.G.S.
25½ S 68½ W
Chile-Argentina border
H: 02 31 00
Brébeuf
iP 02 42 23 c
S 02 51 35

19 décembre

U.S.C.G.S.
51 N 157 E
S.Kamchatka
H: 01 18 10

Brébeuf
iP 01 29 48 c

21 décembre

U.S.C.G.S.
51 N 131 W
Queen Charlotte Islands
H: 08 58 53

Brébeuf
eP 09 06 18 c
S 09 12 12
LR 09 18 38
M 09 19 20

22 décembre

U.S.C.G.S.
33½ N 139½ E
Honshu aftershock
H: 23 12 35

Brébeuf
eP 23 26 01

24 décembre

U.S.C.G.S.
Costa-Rica-Nicaragua border
H: 04 34 20

Brébeuf
iP 04 41 23 d

25 décembre

U.S.C.G.S.
48½ N 28 W
N. Atlantic Ocean
H: 09 33 37

Brébeuf
iP 09 39 55 d
S 09 45 02
LR 09 50 35

26 décembre

U.S.C.G.S.
10 S 166 E
Santa Cruz Island
H: 07 46 24

Brébeuf
iP 07 53 54 d

27 décembre

U.S.C.G.S.
24 S 177 W
Tonga Islands
h: about 300 Km
H: 00 14 15

Brébeuf
iP′ 00 32 30

28 décembre

U.S.C.G.S.
38 S 167½ E
Near coast of North Island
New Zealand
h: about 150 Km
H: 14 24 45

Brébeuf
iP′ 14 43 36 d
i 14 44 15
i 14 47 35

28 décembre

U.S.C.G.S.
21 N 109 W
Off S. coast of Baja, Cal.
H: 19 21 30

Brébeuf
iP 19 28 52 c

M. Buist, S.J.