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The origin of "Fujiwhara effect": The Typhoons Postponed the End of World War II

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Summary

- The origin of "Fujiwhara effect“ was investigated by bibliographic survey. The following hypothesis suggested.
- "Fujiwhara effect“ is NOT the effect suggested by Japanese meteorologist Sakuhei Fujiwhara (1884-1950).
  - It was theoretically derived initially by Japanese meteorologist Diro Kitao (1853-1907) in his paper Kitao (1889).
  - Bernhard Haurzitz (1905-1986) analyzed detailed motion of two typhoons in late August 1945 with input from Herbert Riehl (1915-1997) , and confirmed his theory of two cyclone rotation based on Kitao (1889).

Summary（cont.）

- The word of "Fujiwhara effect“ was generated very finely timed in the closing days of World War II.
  - Damage to U.S. forces during WW II by typhoons was a motive that they established a accurate typhoon tracking in North West Pacific.
  - Kitao’s theory of two cyclone rotation was initially demonstrated by motion of two typhoons (Susan and Ruth in U.S. name) in late August 1945, that progressed slowly in the western Pacific between Okinawa and the main Japanese islands interacting each other.

Summary（cont.）

- It was believed that these typhoons postponed McArthur's occupation plan of Japan for 48 hours.
- U. S. people knew their enemy believed that "Kamikaze" (that is typhoon) is heaven-sent and immortalized Japan.
- Meteorologists in U.S. knew that Fujiwhara who was Director of meteorological service of Japan in 1945 had studied interaction between two vortexes.
- Some experts in meteorological services in U. S. named this process “Fujiwhara”, possibly after his death in 1950.
- Riehl and Haurwitz must know this “effect” should not be called with “Fujiwhara”.

Fujiwhara effect

One of the few eponyms in meteorology with Japanese name

The tendency of two nearby tropical cyclones to rotate cyclonically about each other as a result of their circulations' mutual advection. This occurs with some frequency in the northwestern Pacific basin, where it presents a significant forecast challenge, but happens more rarely in other ocean basins.

Glossary of Meteorology Second Edition: American Meteorological Society, 2002

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FUJIWHARA Sakuhei (1884-1950)
Director of Central Meteorological Observatory from July 1941 to March 1947

The earliest usages are found in U.S. Scientic literatures on 1951

Burgner, Newton M. "The Movement of Hurricanes" Weatherwise 4(1951): 101-105

In 1922, Fujiwhara showed how two cyclonic centers tend to rotate cyclonically around each other. This condition can be considered as a special type of combination internal-external forces effect. An example of this so-called Fujiwhara effect is found in hurricanes KING and LOVE of the 1950 season.

Cressman, George P. "The Development and Motion of Typhoon 'Doris' 1950." Bulletin of the American Meteorological Society 32 (1951): 326-333.

typhoon

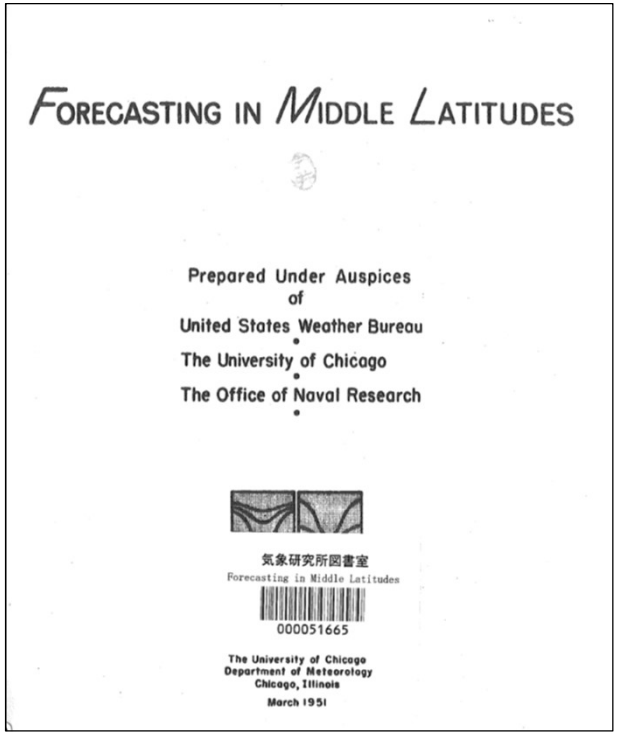
The problem of forecasting the motion of typhoons is then a problem of evaluating the steering and related effects such as the "Fujiwhara effect" (the tendency for two cyclones to rotate counterclockwise about each other) , and a problem of estimating the northward acceleration which must be added to the steering effect.

These expression suggest the term "Fujiwhara effect" was already commonly known among U. S. Meteorologist (who was the readers of these magazines in this time).

Possible usage in 1950 lectures

FORECASTING IN MIDDLE LATITUDES (1951)

- Record of lectures presented by Herbert Riehl (1915-1997) in 1950.
- Lectures on forecasting theory for mid latitudes (extratropical cyclone)
- Sudden description of ”Fujiwhara rule” (same meaning of ”Fujiwhara effect”) in upper blocking expression.
- A example of “spectacularly illustrated by some hurricane



special care regarding the curvature of the path.

This is perhaps the most appropriate place to introduce the famous Fujiwhara rule (22):

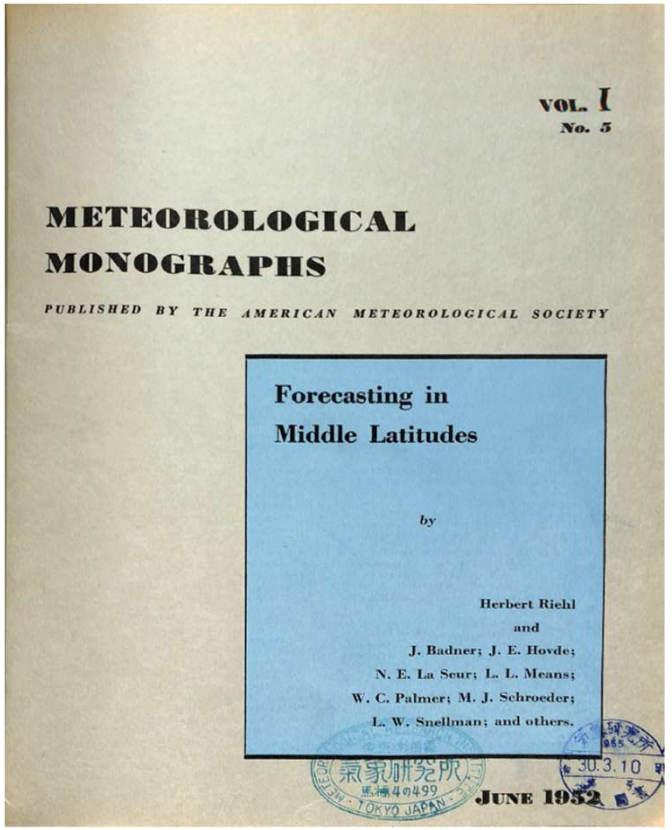
Cyclones of equal intensity tend to revolve about each other in a counter-clockwise sense.

This rule, spectacularly illustrated by some hurricane pairs, though not by all, sometimes serves to advantage also in middle and high latitudes when two closed lows adjoin. When the centers are not of equal intensity, the weaker one will rotate about the stronger one and gradually dissipate. Note that a translation of both centers can be superimposed on the rotation.

Possible usage in 1950 lectures (cont.)

FORECASTING IN MIDDLE LATITUDES (1952)

- The preceding text was published as an AMS Monograph in 1952.
- Only one sentence including ”Fujiwhara rule” was deleted.
- It is very likely that Riehl deleted it.



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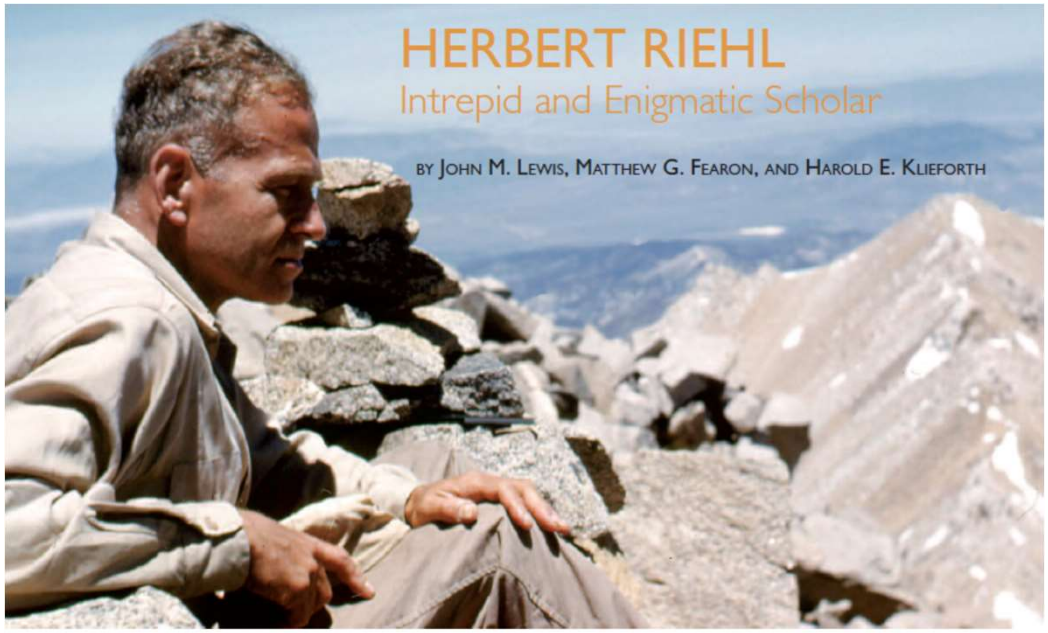
care regarding the curvature of path.

(2) Cyclones of equal intensity tend to revolve around each other in a counterclockwise sense [21]. This rule, spectacularly illustrated by some hurricane pairs, sometimes serves to advantage also in higher

“Father of Tropical Meteorology” and WW II



After escaping Germany in 1933 followed by a venture on Wall Street, Riehl was drawn into meteorology by war, found his calling in Rossby's School, and went on to become the "father of tropical meteorology."

The pathways that led thousands of scientifically and mathematically inclined young people into meteorology during World War II (WWII) exhibited a wide variance as might be expected. The course followed by Herbert Riehl (1915–97) was one of the most unusual—a passageway that began in 1933 when his Jewish mother realized that escape from Nazi Germany was critically important to the welfare of her only child, 18-year-old Herbert. And although it would be another seven years before Riehl entered the field of meteorology, once he embarked on this course it quickly

Lewis et al.(2012) “Herbert Riehl: Intrepid and Enigmatic Scholar,” *Bull. Am. Meteorol. Soc.*, vol. 93

After escaping Germany in 1933 followed by a venture on Wall Street, Riehl was drawn into meteorology by war, found his calling in Rossby's School, and went on to become the "father of tropical meteorology.“

In response to Japan’s military expansion into the tropical latitudes, Rossby approached the U.S. Army Air Corps Directorate of Weather and asked them to consider an augmentation to the 9-month Cadet program at the five universities: the addition of a tropical meteorology component.....By early 1943, the Directorate authorized specialized training in tropical meteorology at Rio Piedras, Puerto Rico, home of the University of Puerto Rico.

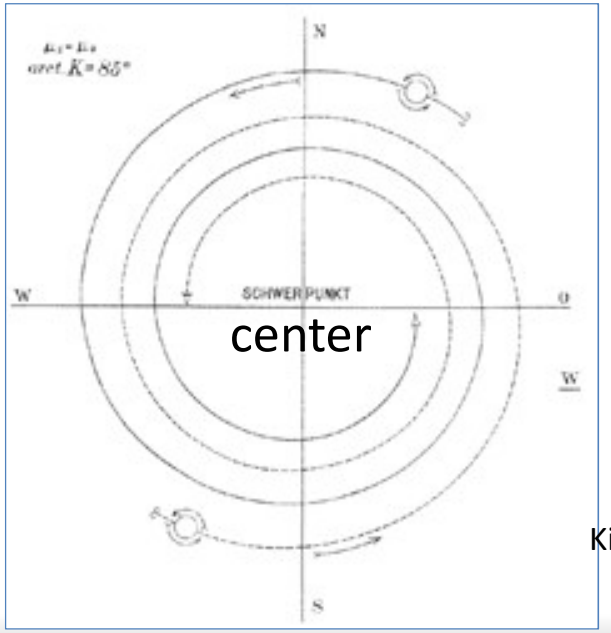
The interaction between two typhoons was first studied theoretically by Diro Kitao (1853-1907)

Beitrage zur Theorie der Bewegung der Erdatmosphare und der Wirbelsturme
(Contributions to the theory of the movement of the Earth's atmosphere and cyclones)（Trilogy, Kitao, 1885, 1889, 1895, The Journal of the College of Science, Imperial University, Japan）

“the course of movement of the two spinal regions for northern hemispheres”

It is nothing less than “Fujiwhara effect”.

Diro Kitao (1853-1907)
1870-83 Study in Germany
learned from Helmholtz
1885 Prof. of Imperial University of Japan
1886 Prof. of Tokyo School of Agriculture and Forestry



Kitao, 1889

The theory of interaction between two cycrones was confirmed by observed motion of typhoons

- Haurwitz studied interaction of vorticies based on Kitao's theory（Kitao, 1887, 1889, 1895）(Haurwitz, 1930).
- Haurwitz confirmed first his theory by motion of typhoons Ruth and Susan at the suggestion of Riehl (Haurwitz, 1946, 1951).

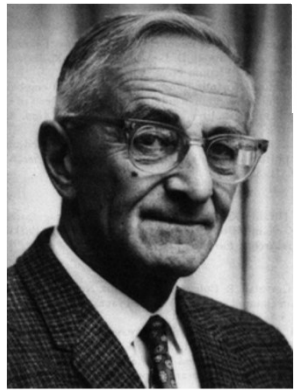
Diro Kitao

Acknowledgments.

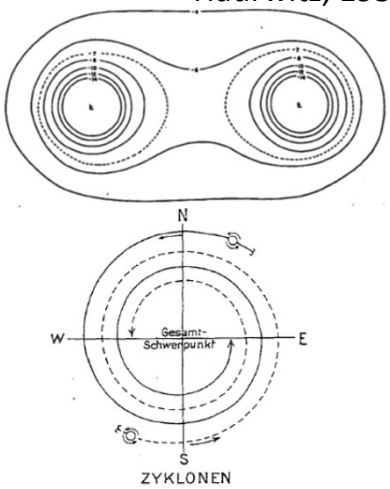
The author is indebted to Dr. BADGLEY, now at the University of Washington, for performing the laborious and largely discouraging computations leading to Table 1. He wishes to express his thanks to Professor H. RIEHL who called his attention to the motion of SUSAN and RUTH, which gave the first confirmation of equation (6). Copies of the relevant

Haurwitz, 1951

moe.met.fsu.edu



National Academy of Sciences



Haurwitz, 1929

"After an epistolary communication of Prof. Fujiwhara, some copies of the work Kitao's were provided by him or by the Meteorological Society of Japan in the Central Meteorological Observatory, Tokyo."

気象庁提供

[1]) Nach einer brieflichen Mitteilung von Herrn Prof. Fujiwhara sind noch einige Exemplare der Arbeiten Kitaos durch ihn oder durch „the Meteorological Society of Japan in the Central Meteorological Observatory, Tokyo" zu bekommen.

Fujiwhara published numerous papers about interaction between two vortexes in 1920's and 1930's in style of his own.

- Fujiwhara, S. (1921), The natural tendency towards symmetry of motion and its application as a principle in meteorology. Q.J.R. Meteorol. Soc., 47: 287–292.
- Fujiwhara, S. (1922), On the growth and decay of vortical system and the mechanism of extratropical cyclones, Japanese J. Astron. Geophys, Vol. 1, 125-182.
- Fujiwhara, S. (1923a), On the growth and decay of vortical systems. Q.J.R. Meteorol. Soc., 49: 75–104.
- Fujiwhara, S. (1923b), On the mechanism of extratropical cyclones. Q.J.R. Meteorol. Soc., 49: 105–117.
- Fujiwhara S., (1925), Examples of Cyclones and Depressions of Pure Thermal and Pure Dynamical Origin, Journal of the Meteorological Society of Japan. Ser. II, 3, en1-en5
- Fujiwhara, S. (1929), , On the behavior of lines of discontinuity, cyclones and typhoons in the vicinity of Japan, Geophys. Mag., 2: 120-131, Tokyo.
- Fujiwhara S., (1931), Short note on the behavior of two vortices. Proc. Phys. Math. Soc. Japan, Ser. 13, 106–110.
- Fujiwhara S. et al., (1935), On vorticity in the atmosphere as a weather factor, J. Fac. Sci., Imp. Univ. of Tokyo, Sec. 1, v. 3, pt.2, 65-106.

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It looks like that Fujiwhara have interest with growth and decay of vortexes, no interest with rotation direction.

“The most spectacular example of the is the rotation of hurricane pairs.” Riehl, 1954

Herbert Riehl (1915～1997)

“**Tropical Meteorology**”(1954)

Interaction between vortices has been studied especially by Fujiwhara (22, 23); it has also been investigated by Haurwitz (31). Figure 11.36

This example confirmed the theory of two cyclone rotation.

clockwise with time. The most spectacular example of such interaction is the rotation of hurricane pairs. Among many examples Figs. 11.43 and 11.44 illustrate a famous pair which, late in August, 1945, delayed urgent diplomatic negotiations. The vortices were of equal intensity

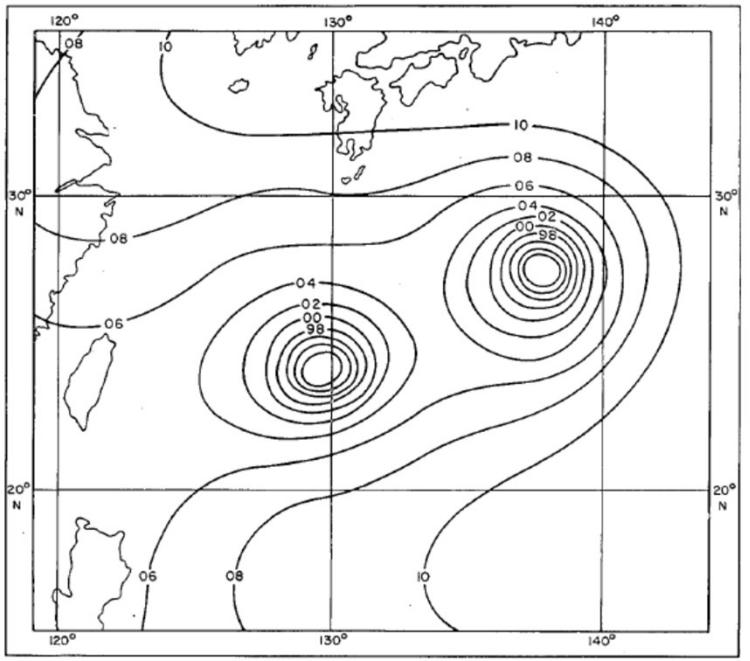


Fig. 11.43. Surface chart, Aug. 25, 1945, for the western Pacific (31).

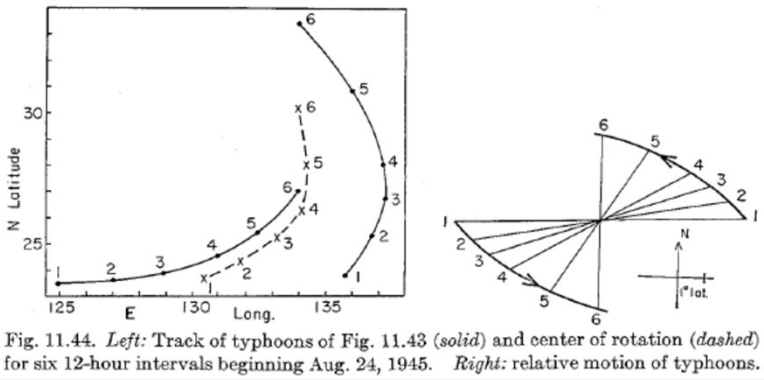
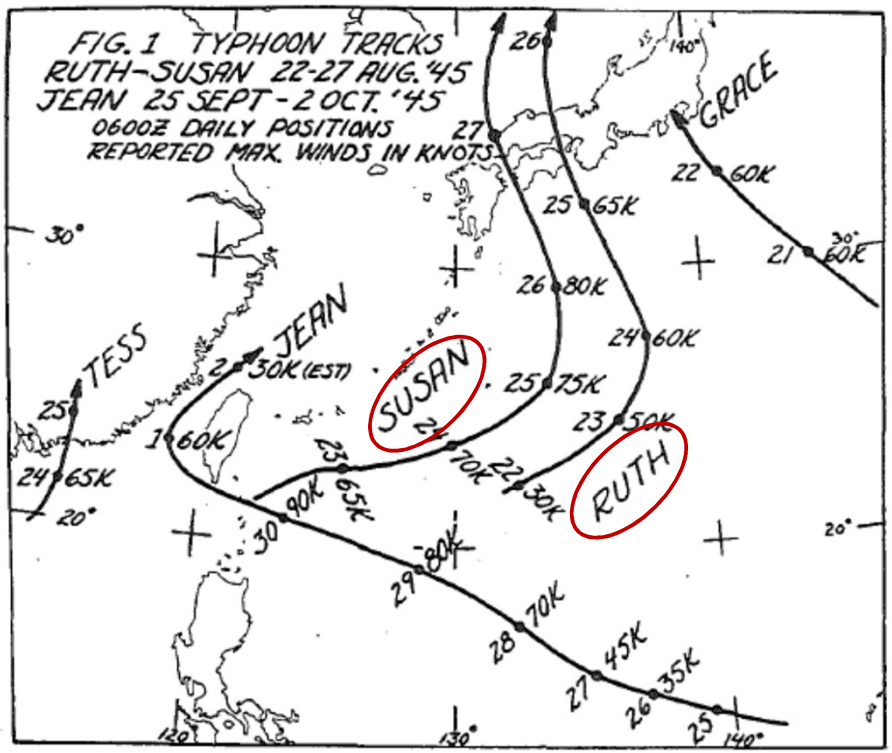


Fig. 11.44. *Left:* Track of typhoons of Fig. 11.43 (*solid*) and center of rotation (*dashed*) for six 12-hour intervals beginning Aug. 24, 1945. *Right:* relative motion of typhoons.

“a famous pair which … delayed urgent diplomatic negotiations”

"The presence of typhoons Ruth and Susan caused 48-hour delay in Supreme Allied Commander McArthur's plans to land occupation forces in Japan"



TYPHOONS RUTH AND SUSAN † (ALSO TESS AND GRACE), 22–27, AUGUST 1945

(*Figs. 2 to 4*)

These four tropical cyclones of storm of typhoon intensity that appeared almost simultaneously present a most spectacular and interesting example of formation and movement. The presence of typhoons *Ruth* and *Susan* caused a 48-hour delay in Supreme Allied Commander MacArthur's plans to land occupation forces in Japan.

* Published with permission of the War Department.
† The Army Air Forces Weather centrals in the SW Pacific in 1945 began the custom of identifying tropical storms by first names of wives of their commanding officers.—*Ed.*

Kidd and C. Reed (1946) "A study of several typhoons in the West Pacific, 1945," Bull. Am. Met. Soc, vol. 27.

McArthur's statement on Aug. 25

Chicago Daily Tribune
AN AMERICAN PAPER FOR AMERICANS
THE WORLD'S GREATEST NEWSPAPER
British arrive near New Amsterdam, Aug. 25, 1664. (Story Inside)
★★ FINAL
VOLUME CIV.—NO 204 C SATURDAY, AUGUST 25, 1945—24 PAGES * THREE CENTS—PAY NO MORE

TYPHOONS DELAY SURRENDER

America Spurns British Plea for More Lend-Lease

PROGRAM OVER, WORLD WARNED BY CROWLEY

Protest of Attlee Goes Unheeded

'SONNY' SETS 'EM UP AND UNFOLDS HIS PEACE PLAN

MODERN SIMPLE SIMON

WHEE!

Expect 1945 Auto Output of 500,000

ALL LANDINGS POSTPONED 48 HOURS BY MACARTHUR

Soldiers Line Rails of Troopships; British Along

One Storm 350 Mi. from Tokyo; 2d Off Hong Kong

Chicago Daily Tribune- Aug 25, 1945

"A series of typhoons raging in the Western Pacific between Okinawa and Japan will delay the landing of the occupation forces for 48 hours. It is hoped by that time the wind and seas will have abated to an extent that will permit of our forward movement."

Typhoon and "Kamikaze"

Dec 1944

Figure 23.1: The light carrier Langley *lists sharply to starboard as she is buffeted by winds of the first of Halsey's typhoons.*

790 men lost their lives as three destroyers sank. An additional nine ships received extensive structural damage.
146 aircraft were lost or severely damaged.
This disaster was the navy's largest noncombatant loss in history.(Guard et al. 1992)

Kerry Emanuel 2005 "Divine Wind: The History and Science of Hurricanes"

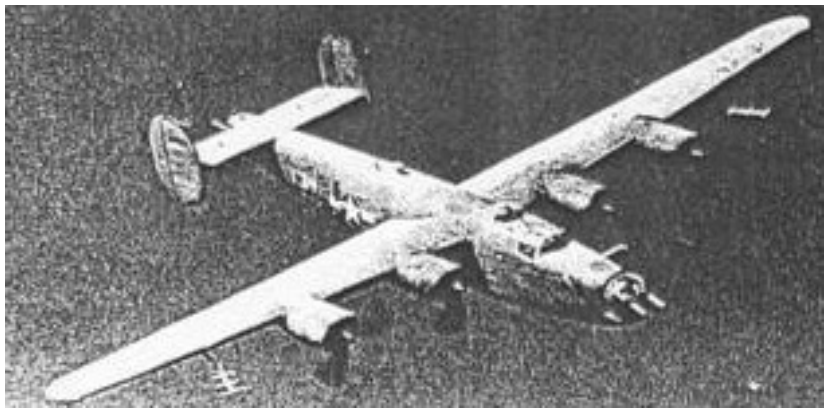
Jun 1945

U.S.S. *Pittsburgh* minus her Bow
(Morison 1960)

Six men were killed and four more seriously injured.
The cruiser *Pittsburgh* had 104 ft of her bow wrenched off.
All four carriers were damaged.
The forward flight decks of the *Hornet* and *Bennington* collapsed.
The *San Jacinta's* hull buckled
Some 76 aircraft were lost.
（Emanuel 2005）

- Twice devastation of Third Fleet by typhoons resulted in the use of military aircraft for typhoon reconnaissance with establishment of the Typhoon Tracking Center on Guam in June 1945.
- Typhoon location and motion became known exactly.

www.coldwar.org



The first recorded eye penetration in the western Pacific occurred on 12 August by a PB4Y-l aircraft flying out of Iwo Jima. (Guard et al. 1992)

Typhoon and "Kamikaze" (cont.)

This article suggest that damages on U.S. forces including twice devastation of Third Fleet by typhoons (that is Kamikaze) shocked U.S. people.

But 'Divine Tempests' Don't Halt Americans

It is significant that kamikaze, the Japanese term for the divine tempest, is likewise the name of the suicide corps in the present struggle. "If at present the divine winds do not seem to be blowing in Japan's favor, it is because the people have not given enough of themselves to the war against the Americans," the Japanese are told.

The Japanese faith in divine tempests suffered a rude shock in recent months. Twice the typhoons have struck the American fleets, but could not break them, nor even interrupt their attacking operations. In December, the storms wrecked three destroyers and several other craft during the Mindoro landings. In June a typhoon injured 21 ships of Admiral Halsey's 3rd fleet, tore the bow off the cruiser Pittsburgh and forced other units to turn back—but the main fleet plowed right ahead and three days later gave Kyushu a shellacking.

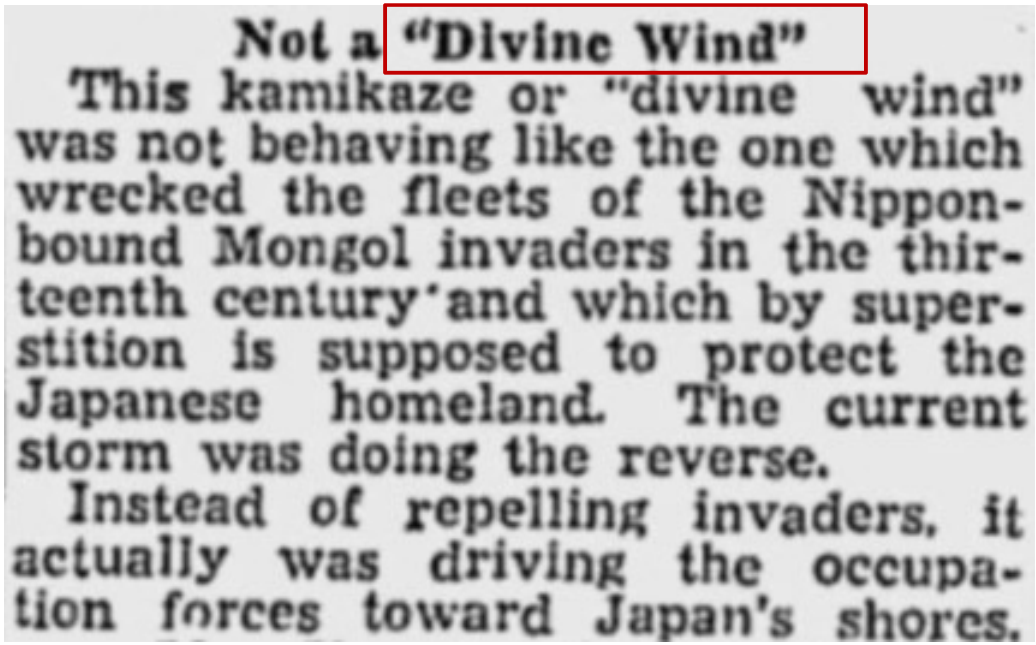
The tempests which wrecked Kubla Khan's plans don't stop the Americans.

Fail Nips

The Milwaukee Journal - Jul 26, 1945

Typhoon and “Kamikaze” (cont.)

This article suggest that postpone of the occupation because of typhoons (that is Kamikaze) shocked U.S. people.



Not a "Divine Wind"

This kamikaze or "divine wind" was not behaving like the one which wrecked the fleets of the Nippon-bound Mongol invaders in the thirteenth century and which by superstition is supposed to protect the Japanese homeland. The current storm was doing the reverse.

Instead of repelling invaders, it actually was driving the occupation forces toward Japan's shores.

The Lewiston Daily Sun - Aug 27, 1945

Is it only a new example of "the zeroth theorem" ?

The zeroth theorem of the history of science:

a discovery (rule, regularity, insight and so on) named after someone did not originate with that person (Jackson, 2008).

Only hypothesis is proposed here.

It requires further validation.

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