# ABSTRACT

In 1958, there were twenty nine tropical cyclones occurred in the district of North Western Pacific. Among them, only Typhoon Winnie and a tropical storm had landed at eastern coast of Taiwan. Typhoon Winnie had a casualty of fourty three lives and a great loss of properties. Another typhoon was named Grace, She whirled along a path which was about 40 kms apart from the east coast of Taiwan. Another four lives had been lost in this storm and many houses had been torn down. The general aspects of these three typhoons will be briefly stated as follows:

1) Typhoon winnie, was first appeared in the synoptic chart of 11st July and was located at $16° N$ and $135° E$. Her intensity was soon reached to the stage of a typhoon. On the morning of 12 th, She began to move toward the coast of Taiwan. Her kinetic energy and potential energy at her mature stage had been calculated at about $1.2 \times 10^{25}$ ergs and $1.3 \times 10^{26}$ ergs respectively during the night of 13th, July. She moved continuously northwestward to the south east coast of Taiwan and landed at the vicinity of Hwalien during the night of 15th. It was dissipated suddenly due to orographic effests. Later, a case of regeneration had happened over the sea in the Taiwan strait. This storm had caused a great damage and made a deluge at eastern part of Taiwan. Winnie later hit the coast of Jukien and moved on to the mainland of China on morning of 16th, and then went into dissipation.

Damages repoted in this typhoon were relatively greater in eastern part than the western part of Taiwan. Fourty three lives had been lost in the storm and more than seven thousand houses had ruined. The highest wind velcity recorded at Hwalien was 54.2 m/s, and a maximun total amount of rain fall reported at Dawu was 581.0 mm.

2) A tropical storm which no name has been designated bec-

ause of its intensity did not reach the level of a typhoon. She was formed on 26th August at 17°N. 129°E in the Pacific with its moving direction westward. Two days later, the direction of the storm turned to north west instead of west on 28th of the month.

At her mature stage, her kinetic and potential energy were computed to a value of $0.29 \times 10^{24}$ ergs and $0.32 \times 10^{25}$ ergs respectively. At noon of 29th, She landed at the North of Hwalien then moved accross the Island and entered theTaiwan Strait and finally hit the coast of the mainland China on the morning of 30th. During the passage of this tropical storm, no damage was reported in Taiwan.

Highest wind veloaity at Lanyu was reported to be 21.3m/s, and a maxmum total amount of rainfall 124.3 mm was recorded at keelung.

3) Typhoon Grace was whirl about at the south of Calolines on 28 th August. She increased her force rapidly to the stage of a typhoon and reached a maximum wind velocity to 55m/sec near the centre at 48 hours after her birth.

On the morning of 3rd September, Typhoon Grace already approached to the east coast of Taiwan at a distance of 40 kms. The typhoon centre passed at a close distance to Penkiayu. Typhoon Grace travelled the western part of East China sea and later moved on to the mainland of China at noon of 4th and changed her moving direction to the Northeast. At her mature stage the kintic and potential energy of Typhoon Grace computed to a value $8.3 \times 10^{24}$ ergs and $9.2 \times 10^{25}$ ergs respectively on the night of 1st. Sept. Damages had been done during the passage of this typhoon mainly were at the eastern and the northern secters of Taiwan. Four people had lost their lives and more than four hundred houses were ruined. Highest wind velocity of 43.8m/s and a maximnm total amount of rainfall of 120.9 mm. in this storm were both recorded at Keelung.

# Ｉ　北太平洋西部颱風概況

## 1. 緒　論

　　本年度北太平洋西部計發生颱風二十九次，於臺灣附近通過者及登陸者計參次。其中以七月十五日登陸花蓮南方之溫妮（Winnie）颱風所造成之災害最為嚴重。其他則以九月三日晚掠過臺灣北方海面之葛瑞絲（Grace）颱風有輕微災害。尚有登陸臺灣之中度颱風（Tropical storm），本省各地曾略受其影響，風速加大並略有降雨，但未釀成災害。此外各次颱風離臺灣均遙遠，未有明顯之影響。

　　本年在北太平洋西部發生之二十九次颱風中，以溫妮（Winnie），艾麗絲（Alice），海倫（Helen），艾達（Ida），勞娜（Lorna），梅瑞（Marie）及南茜（Nancy）等七次颱風較大。其中尤以艾達颱風規模可稱最大，其最盛期，中心氣壓達 880 毫巴，颱風半徑為 800 公里，其動能約為 $5.3 \times 10^{25}$ 爾格。其次為梅瑞颱風，於其最盛期之中心氣壓為 950 毫巴，但其颱風半徑很大，竟達 1200公里。

　　本年度在北太平洋西部所發生之颱風經過路徑情形，根據本所每日天氣所繪得之結果，如第一圖及第二圖所示。參閱該圖可以明瞭各颱風之動態。

　　註）本報告內所用之時間均係東經 120 度標準時間。

## 2. 本年度颱風之發生及其移動之特性

　　本年度在北太平洋西部所發生之颱風，其每月發生次數，侵襲臺灣次數，及其經過路徑情形，根據本所每日天氣圖所調查之結果，如一表及第一、二圖所示。茲分述其概略特性。

| 月 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 計 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 發生次數 | 累年平均 | 0.6 | 0.5 | 0.1 | 0.7 | 0.8 | 2.2 | 5.4 | 6.6 | 5.4 | 4.0 | 2.0 | 1.4 | 29.7 |
| | 1958年 | 0 | 0 | 0 | 1 | 1 | 3 | 7 | 4 | 6 | 3 | 2 | 2 | 29 |
| 侵襲臺灣次數 | 累年平均 | | | | | | 0.1 | 0.2 | 1.3 | 0.5 | 1.0 | | | 3.1 |
| | 1958年 | | | | | | | 1 | 1 | 1 | | | | 3 |

　　本年在北太平洋西部所發生之颱風次數與累年平均值大略一致，但其月別分佈，在六，七，九月發生較多，八月發生略少。且其侵襲臺灣之次數及月別分佈也大略與累年平均值一致。

　　關於颱風之經過路徑情形，本年度，一直西進之颱風較少，轉向東北之颱風較多，且其轉向之拋物線軸，五月約在北緯十五度，六月約在北緯二十一度，七月再北移約在北緯二十三度，八月最偏北約在北緯二十五度。九月南廻與七月之位置略同，至十月十一月則又回到五月之位置。總之，拋物線軸之位置，本年度略有偏南之傾向。又其轉向點，大概在東經一百三十度以東，唯十月及十一月略偏西，約在東經一百二十五度附近。

　　無論在理論上及實際上，颱風徑路之轉變多為太平洋高氣壓之盛衰所左右。故本年度之轉向點之偏東現象，大概為太平洋高氣壓之活動較不活潑並且不向西南伸展所致。

# 3. 颱風之能量

　　颱風持有莫大之能量，自其強烈之破壞力可想像之。晚近之研究，已熟知颱風之動能與其損害成正比例。玆以高橋博士之方法，估計今年發生於北太平洋西部之各颱風之動能及位能，以資參考。

　　所謂能量方程式可寫成

$$\frac{\partial}{\partial t}(I+K+U)=\iiint \wp(\nabla \cdot \overline{m})dxdydz-\int \wp v_n ds-\iiint J\rho\frac{dQ}{dt}dxdydz. \quad (1$$

其中　　$I=J\ C_v \iiint \rho T\ dxdydz$　為內能(Internal Energy)，

$K = \frac{1}{2} \iiint \rho (\mathbb{V} \cdot \mathbb{V}) dxdydz$ 爲動能 (Kinetic Energy)，

$U = \iiint \rho \, gzdxdydz$ 爲位能 (Potential Energy)，

$J \, dQ/dt$ 爲單位時間內供應單位體積之空氣之熱量，$J$ 爲熱功常量，$Q$ 爲熱量，$t$ 爲時間，$\rho$ 爲空氣之密度，$\mathbb{V}$ 爲風速，$\mathbb{F}$ 爲摩擦力，$P$ 爲氣壓，$S$ 及 $Vn$ 各爲境界面之表面及其法線方向之風速，$C_v$ 及 $Cp$ 各爲空氣之定積及定壓比熱。

於上式中，使用絕熱變化之假定及內能與位能有成比例之關係，可得下面之方程式。

$$\frac{\partial}{\partial t}(K+bU) = \iiint \rho (\mathbb{V} \cdot \mathbb{F}) \, dxdydz - \int p V_n \, ds \circ \qquad (2)$$

其中 $b = \dfrac{Cp}{Cv}$ 爲一常數。上式之左邊爲氣壓系統全能量之時間變化，而右邊之第一項爲摩擦力消費之能量，第二項爲氣壓所做之功。當然颱風之能量爲氣壓系統全能量減去一般場 (General Field) 之能量，故可以當全能量之變分 (Variations) $\delta(K+bU)$ 爲颱風之能量估計之。

首先將估計位能。由上述之定義，颱風之位能 $\delta U$ 可以寫成

$$\delta U = \delta \iiint \rho \, gz \, dxdydz = -\iiint \rho (\delta p + z d/dz \, \delta p) \, dxdydz \qquad (3)$$

於颱風區域內之氣壓分布，可以使用下記之實驗式表示之，即

$$p = p_\infty - \frac{\triangle p}{1+r/r_0} \qquad (4)$$

其中 $p_\infty$ 爲無颱風影響之區域之氣壓，即表示一般場之氣壓，$\triangle p$ 爲表示中心氣壓深度之常數，$r_0$ 爲表示颱風之水平範圍之常數。若 (3) 式中之氣壓變分 $\delta p$ 由 (4) 式之 $(p - p_\infty)$ 代替，而水平方向使用極座標，垂直方向之積分取由地面至均和大氣之高度 $H$，位能可以寫成

$$\delta U = \int_o^H \int_o^R 2\pi r \, \frac{\triangle p}{1+r/r_0} + z \, \frac{d}{dz} \left(\frac{\triangle p}{1+r/r_0}\right) drdz$$

$$= \int_o^H 2\pi \, r_0^2 (\triangle p + z \frac{d}{dz} \triangle p) \, dz \int_o^R \left\{\frac{r/r_0}{1+r/r_0}\right\} d\left(\frac{r}{r_0}\right)$$

$$= 2\pi \, \frac{R^2}{a^2} \int_o^H (\triangle p + z \frac{d}{dz} \triangle p) \, dz \int_o^a \frac{\xi}{1+\xi} \, d\xi \qquad (5)$$

上式中，$R$ 爲颱風之半徑，$a = \dfrac{R}{r_0}$，$\xi = \dfrac{r}{r_0}$。假定 $\triangle p$ 爲高度 $Z$ 之線型函數而其地表面值爲，$\triangle p_o$ 且假定於均和大氣高度其數值爲零，可得

$$\triangle p = \triangle p_o \, (1 - z/H)$$

$$\therefore \quad \triangle p + z \, d/dz \, \triangle p = \triangle p_o$$

此方程式代入 (5) 式，則得

$$\delta U = 2\pi H \triangle po \frac{R^2}{a^2} \{a - \log(1+a)\} 。 \qquad (7)$$

即颱風之位能。

次之將估計動能，由前述之定義，颱風之動能 K 為

$$K = \frac{1}{2}\iiint \rho(\vec{V}\cdot\vec{V})dx\,dy\,dz = \int_o^{H\infty}\int_o^{R}\frac{2\pi r\rho}{2}(\vec{V}\cdot\vec{V})drdz \qquad (8)$$

經驗上，颱風區域內之速分布，大略與旋衡風 (Cyclostrophic wind) 一致。因此由颱風之氣壓分布之實驗式 (4)，可得知颱風區域內之風速分布為

$$\vec{V} = \sqrt{\frac{r}{\rho}\frac{\partial p}{\partial r}} = \sqrt{\frac{\triangle p}{\rho}}\frac{\sqrt{\frac{r}{r_0}}}{1+\frac{r}{r_0}} \qquad (9)$$

此方程式代入 (8) 式，可得颱風之動能為

$$K = \int_o^{H}\int_o^{R}\pi r\;\rho\frac{\triangle p}{\rho}\frac{r/r_0}{(1+r/r_0)^2}\,dr\,dz$$

$$= \pi\frac{R^2}{a^2}\int_o^{H\infty}\triangle pdz\int_o^{a}\frac{\xi}{(1+\xi)^2}dzdr$$

其中 $H\infty$ 為颱風之上限，約為10 公里之高度。若使用 (6) 式之關係，則可得颱風之動能 K 為

$$K = \frac{\pi}{2}\triangle po\,H\infty\;\frac{R^2}{a^2}\{\log(1+a) - \frac{a}{1+a}\} \qquad (10)$$

在估計時，颱風半徑 R 之決定為一問題。此次之估計，姑以最大圓形等壓線內之範圍為颱風範圍而選定其半徑 R，因此 $a=R/r_0$ 大略等於 1/5。又經驗上已知，颱風中心附近之風速分布，大略與旋衡風一致，但在其外圍，其風速分布常較旋衡風小。乃於動能計算時，如使用旋風，其估計常大於實際之能量。因此應施以誤差訂正。且 $\triangle po$ 以毫巴，R 以 111 公里為單位計量，則位能及動能之方程式 (7) 及 (10) 可寫成

$$\delta U = 0.78\times 10^{23}\,\triangle po\,R^2\;爾格\;(ergs)$$

$$K = 0.71\times 10^{22}\,\triangle po\,R^2\;爾格\;(ergs)$$

應用上述之兩方程式，計算今年發生於北太平洋西部之各颱風之最盛期之位能及動能，其結果如第二表所示。今年發生於北太平洋西部之颱風中，艾達 (Ida) 颱風威力最大，其位能及 $5.9\times 10^{26}$ 爾格，動能為 $5.3\times 10^{25}$ 爾格。其次為梅瑞 (Marie) 颱風。又今年侵襲臺灣之三次颱風中，溫妮颱風威力最大，位

能爲 $1.3 \times 10^{26}$ 爾格，動能爲 $1.2 \times 10^{25}$ 爾格。葛瑞絲 (Grace) 颱風次之，其位能爲 $9.2 \times 10^{25}$ 爾格，動能爲 $8.3 \times 10^{24}$ 爾格。

### 第二表 1958年發生於北太平洋西部颱風之能量
### Table II-Computed Energies of typhoos in North western Pacific in 1958.

| 颱 風 名 | 月 日 | 中心氣壓 (mb) | R (111Km) | $\triangle p_0$ (mb) | 動 能 (K) (ergs) | 位 能 ($\delta$U) (ergs) |
|---|---|---|---|---|---|---|
| T. S. | 4.29 | 995 | 1.6 | 13 | $0.24 \times 10^{24}$ | $0.26 \times 10^{25}$ |
| Phyllis | 5.29 | 940 | 4.2 | 70 | $9.5 \times 10^{24}$ | $1.0 \times 10^{26}$ |
| Rita | 6.10 | 985 | 2.6 | 23 | $1.1 \times 10^{24}$ | $1.2 \times 10^{25}$ |
| T. S. | 6.11 | 998 | 3.0 | 08 | $0.51 \times 10^{24}$ | $0.56 \times 10^{25}$ |
| Susan | 6.15 | 985 | 2.2 | 21 | $0.72 \times 10^{24}$ | $0.80 \times 10^{25}$ |
| Tess | 7.02 | 995 | 2.7 | 13 | $0.67 \times 10^{24}$ | $0.74 \times 10^{25}$ |
| Viola | 7.11 | 965 | 2.5 | 41 | $1.8 \times 10^{24}$ | $2.0 \times 10^{25}$ |
| Winnie | 7.13 | 925 | 4.5 | 80 | $1.2 \times 10^{25}$ | $1.3 \times 10^{24}$ |
| Alice | 7.19 | 925 | 4.8 | 80 | $1.3 \times 10^{25}$ | $1.4 \times 10^{26}$ |
| Betty | 7.15 | 985 | 2.4 | 15 | $0.61 \times 10^{24}$ | $0.67 \times 10^{25}$ |
| Dris | 7.27 | 950 | 3.8 | 58 | $5.9 \times 10^{24}$ | $6.5 \times 10^{25}$ |
| T. S. | 7.23 | 994 | 2.3 | 06 | $0.23 \times 10^{24}$ | $0.25 \times 10^{25}$ |
| Elsie | 8.07 | 965 | 3.8 | 43 | $4.4 \times 10^{24}$ | $4.9 \times 10^{25}$ |
| T. S. | 8.08 | 995 | 1.4 | 10 | $0.14 \times 10^{24}$ | $0.15 \times 10^{25}$ |
| Flossie | 8.24 | 970 | 4.5 | 38 | $5.5 \times 10^{24}$ | $6.0 \times 10^{25}$ |
| T. S. | 8.29 | 998 | 2.6 | 06 | $0.29 \times 10^{24}$ | $0.32 \times 10^{25}$ |
| Grace | 9.01 | 910 | 3.5 | 95 | $8.3 \times 10^{24}$ | $9.2 \times 10^{25}$ |
| T. S. | 9.11 | 990 | 5.0 | 14 | $2.5 \times 10^{24}$ | $2.7 \times 10^{25}$ |
| Helen | 9.13 | 920 | 6.6 | 88 | $2.7 \times 10^{25}$ | $3.0 \times 10^{26}$ |
| Ida | 9.24 | 880 | 7.2 | 125 | $5.3 \times 10^{25}$ | $5.9 \times 10^{26}$ |
| June | 9.21 | 990 | 3.3 | 15 | $1.2 \times 10^{24}$ | $1.3 \times 10^{25}$ |
| T. S. | 9.28 | 1002 | 1.4 | 06 | $0.08 \times 10^{24}$ | $0.08 \times 10^{25}$ |

| | | | | | |
|---|---|---|---|---|---|
| Kathy | 10.24 | 975 | 4.8 | 33 | $5.4 \times 10^{24}$ | $5.9 \times 10^{25}$ |
| Lorna | 10.30 | 945 | 7.2 | 63 | $2.3 \times 10^{25}$ | $2.6 \times 10^{26}$ |
| Marie | 10.29 | 950 | 10.8 | 58 | $4.8 \times 10^{25}$ | $5.3 \times 10^{26}$ |
| Nancy | 11.24 | 920 | 4.5 | 86 | $1.2 \times 10^{25}$ | $1.3 \times 10^{26}$ |
| T. S. | 11.30 | 1000 | 5.0 | 08 | $1.4 \times 10^{24}$ | $1.5 \times 10^{25}$ |
| Olga | 12.05 | 950 | 4.0 | 55 | $6.2 \times 10^{24}$ | $6.9 \times 10^{25}$ |
| T. S | 12.11 | 985 | 2.2 | 20 | $0.69 \times 10^{24}$ | $0.76 \times 10^{25}$ |

(T. S. 爲中度颱風 Tropical Storm)

# II 溫妮颱風報告

## 1. 颱風之發生與經過

溫妮颱風自其發生於菲律賓東方海洋上以至登陸本省，經臺灣海峽而進入大陸消失，爲期不過短短七日，而其發展之速，實爲以往侵襲臺灣颱風所少見。當7月11日衛歐拉（VIOLA）颱風沿東經 140 度線北移之時，在菲律賓東方海洋上（約北緯16度，東經135度）另一熱帶風暴卽已醞釀發展，此卽爲溫妮（WINNIE）颱風生成之先聲。至12日8時經美軍飛機偵察報告，已迅速發展達強烈颱風強度，其中心氣壓爲960毫巴。中心位於北緯17.6度，東經132.3度，最大風速達每秒55公尺，暴風半徑約爲200公里，以每小時15公里之速度向西北方向移動。至13日8時復據美軍飛機偵察報告，中心位於北緯19.6度，東經131.1度，最大風速增達每秒65公尺，暴風半徑復擴大爲300公里，移動方向則稍偏西，約以每小時 15 公里之速度向西北西方向進行，指向臺灣而來。此時其中心氣壓復降低925毫巴。14日8時，此颱風中心位置移至北緯20.7度，東經 127.2 度，中心氣壓稍昇高爲940 毫巴，仍向本省接近。至15日8時，中心位置移至北緯21.9度，東經123.4度，僅距臺東東南方約230公里，臺灣東南部已漸進入其風暴範圍。該日15時以後，全省逐漸進入其暴風圈內，各地風力增強，氣壓均急驟下降，東北部地區開始有豪雨。此颱風於15日19時半左右登陸花蓮南方地區，因受陸地之影響，威力頓減，且因臺灣山脈之阻未能直接通過，漸行消失。而於臺中之東南方附近，誘發另一副颱風，逐漸發展其勢力並向西南西緩慢進行。至23時進入臺灣海