委託機關：中央氣象局

計畫名稱：台灣附近海域波浪預報模式研究(三)
（波浪部份）

金　　額：壹佰零貳萬元

時　　間：民國 75年 7 月 1 日至民國 76年 6 月 30 日

計畫主持人：所長　梁 乃 匡

研究人員：簡 仲 璟
洪 憲 忠
蘇 青 和
吳　 基
江 中 權

目　　　　錄

一、引　言

梁　乃　匡

本報告為四年波浪預報計畫的第三年成果。首先利用中央氣象局提供的冬季網格點風速風向資料，以及測站的波浪記錄，求出各站的經驗常數，然後用另一段資料來驗證。由於過去推算的湧浪週期並不理想，而週期影響湧浪到達的時間，因此加以重新探討；利用民國74～75年間8個颱風及在蘇澳測得的波浪資料，求出新的推算公式。本模式所採用的颱風波浪推算法為 Bretschneider 所提出，其中波浪場關係直接由所提出的圖迴歸而得。今仍依 Bretschneider 所提之基本公式，循等效風域觀念，重新計算波浪場關係，與舊的比較。

二、季風風場有效影響區之設定

簡　仲　璟

由於季風風場已網格點化，對於每一網格可視爲一波浪生成的單位元素風場。此網格形狀近似正方形，隨緯度增大而有較大的變形，在本報告中是以梯形近似之，並假設在元素風場中的風速與風向均勻一致。對於元素風場所產生的波能，因爲距離與時間差的關係，並不一定能全部到達吾欲推算波浪的位置，可能一部分或全部不到達，因此有所謂有效影響區之設定，如圖２－１。設定方法說明如下：

情況(1)

若 $$\left|Ri-DD\right| \geq \frac{L}{2}(\sin\theta+\cos\theta)$$

則 $Ai=0 \qquad i=l, u$

情況(2)

(a)若 $$\left|Ri-DD\right| \geq \frac{L}{2}(\cos\theta-\sin\theta)$$

則 $$Ai=\left(\frac{\frac{L}{2}(\sin\theta+\cos\theta)-\left|Ri-DD\right|}{L\sin\theta}\right)^2\cdot\frac{L^2}{2}\tan\theta$$

(b)若 $$\left|Ri-DD\right| < \frac{L}{2}\left|\cos\theta-\sin\theta\right|$$

則 $$Ai=\left(\frac{L}{2}\left|\cos\theta-\sin\theta\right|-\left|Ri-DD\right|\right)\cdot\frac{L}{\cos\theta}+\frac{L^2}{2}\tan\theta$$

其中

下標 i ： l, u

DD：網格中心點至推算點距離

L ：正方網格邊長

Rl：波能傳遞之下限距離

Ru：波能傳遞之上限距離

Al：由 R_L所求出之參考面積

Au：由R_u 所求出之參考面積

β：網格中心點至推算點之連線與Y軸之夾角

若 $\beta > 45^\circ$ 則 $\theta=90^\circ-\beta$

若 $\beta \leq 45^\circ$ 則 $\theta=\beta$

若Ae：表有效影響區之面積，則

情況：

(1)若 $Rl \leq DD$，且 $Ru \leq DD$

則 $Ae = Au - Al$

(2)若 $Rl < DD$，且 $Ru > DD$

則 $Ae = L^2 - Au - Al$

(3)若 $Rl > DD$ 且 $Ru > DD$

則 $Ae = Al - Au$

因為網格形狀隨緯度增加而變形，而不是正方形，因此 Ae 必須加以修正，若 Ac 表眞實網格面積，則 Ae 修正如下：

$$Aem = Ae \cdot \frac{Ac}{L^2}$$

其中 Aem 表修正之有效影響區之面積。

玆舉一例說明，例設風速15公尺／秒時間差 36小時，D.D=2,000公里，$\beta=30^\circ$，風速資料時間隔 3 小時 $L = 111.12$ 公里，$Ac = 120,000$

則 $Rl = 15 \times 3600 \times 36/1000 = 1944$ 公里

$Ru = 15 \times 3600 \times (36+3)/1000 = 2106$ 公里

$|Rl - DD| = 56$ 公里

$|Ru - DD| = 106$ 公里

$$\frac{L}{2}(\cos 30^\circ + \sin 30^\circ) = 75.9 \text{ 公里}$$

$$\frac{L}{2}\left|\cos 30^\circ - \sin 30^\circ\right| = 20.3 \text{ 公里}$$

因 $|Rl - DD| = 56 < 75.9$

$|Rl - DD| = 56 > 20.3$

故 $$Al = \left(\frac{75.9 - 56}{111.12 \cdot \sin 30^\circ}\right)^2 \cdot \frac{111.12^2}{2} \tan 30^\circ = \left(\frac{19.9}{55.56}\right)^2 \cdot 3564.5 = 457.3$$ 平方公里

$|Ru - DD| = 106 > 75.9$

故 $Au = 0$

因 $R_l = 1944 < 2000$

$R_u = 2106 > 2000$

則 $Ae = L^2 - A_u - A_l$

$= (111.12)^2 - 0 - 457.3$

$= 11890.4$ 平方公里

$$Aem = Ae \cdot \frac{Ac}{L^2} = 11890.4 \ \frac{120000}{12347.7} = 11555.6 \text{ 平方公里}$$

即有效影響區之面積為 11555.6 平方公里

有關有效影響區設立之程式見附錄一中之副程式 EAREA 。

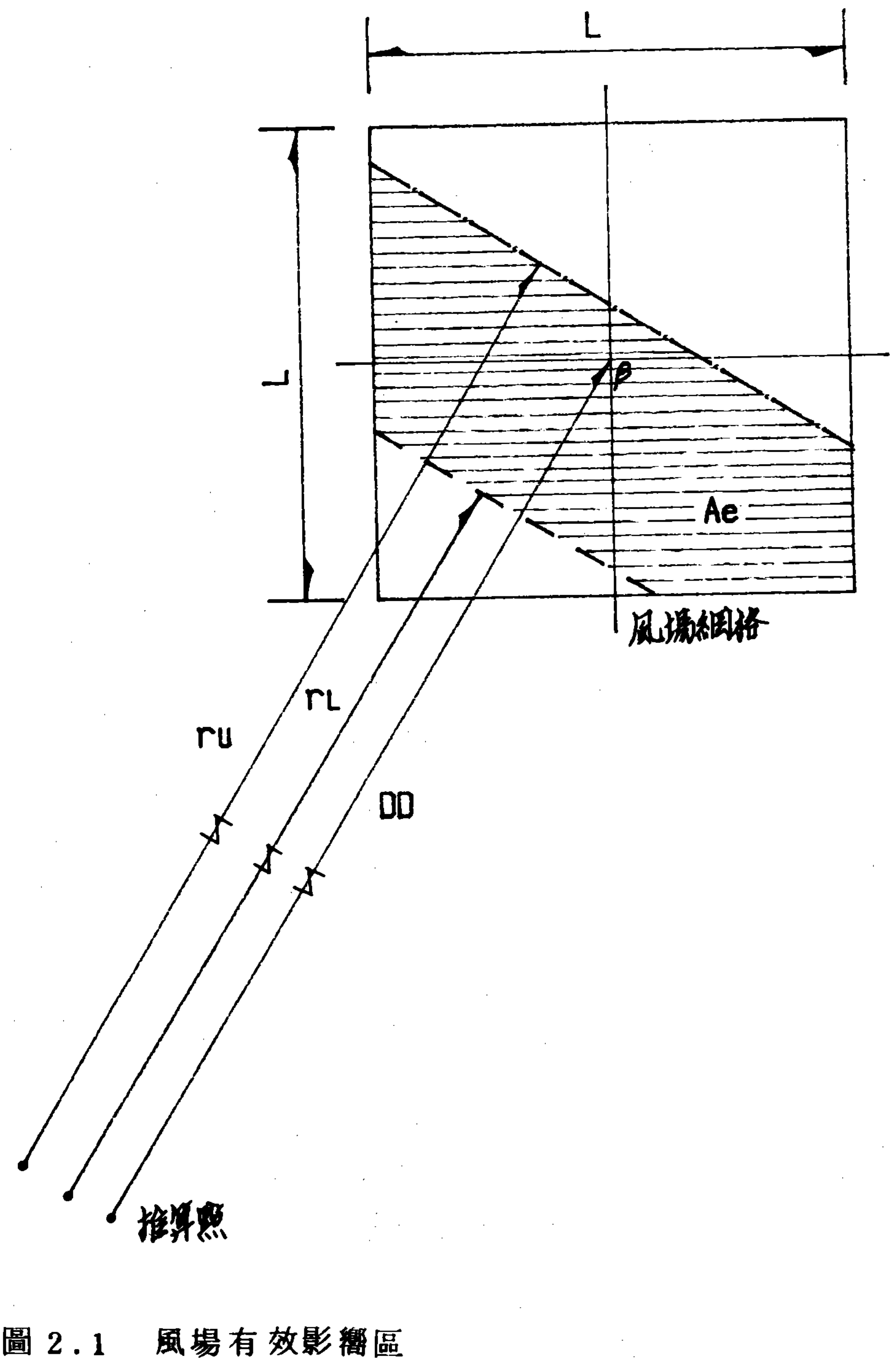


圖 2.1　風場有效影響區

三、由實測資料推求季風波浪經驗常數

簡仲璟、洪憲忠、江中權

由於面積風域法主要觀點爲考慮與浪之間的能量授受，因此我們藉著一段實測季風資料及對應的實測波浪資料，來決定能量授受關係，即經驗常數 $\overline{\xi}$。另外，決定推算週期公式：

$$\frac{gT_{1/3}}{2\pi\overline{U}} = C_2 \left(\frac{g\cdot TDUR}{\overline{U}}\right)^{C_1}$$

$$\frac{gT_{1/3}}{2\pi\overline{U}} = C_4 \left(\frac{g\cdot F}{\overline{U}^2}\right)^{C_3}$$

中的 C_1，C_2，C_3，C_4 值，其中 $\overline{U}$ 爲有效風域平均風速，TDUR 爲吹風延時，F 爲有效風域最長距離。通常經驗常數受各站地點，風域界定及季節的影響而稍有差異。推求經驗常數的風場資料爲由 76/01/18~76/02/01 每三小時一筆，區域範圍則東經 110° 至 135°，北緯 10°~40°，相對應的波浪資料爲由 76/01/23~76/02/01 共有鼻頭角、新港、東吉島、小琉球四個波浪站。由此所求得之經驗常數值如表 3.5 。

以面積風域法推算季風波浪之前，此經驗常數必須先求得，然後再以此常數反推算出季風波浪。推算結果與實測比較如表 3.1，3.2，3.3，3.4。由表中可發現推算結果頗合理，但由於所取風場沓料爲三小時一筆故推算實測值變動較小。以後或許可變風資料之時間間距。由四個站的推算結果發現鼻頭角波浪最大，新港、東吉島次之，小琉球最小，此與實測結果有相同的趨勢，以後應繼續此工作而得更佳之經驗常數值並對其他波浪測站，也進行常數值的求得，及颱風發生時，季風波浪與颱風波浪的合成進行驗證，及調整。

波浪預報程式有二，適用於 VAX—11 780 者，如附錄 I，適用於 IBM 個人電腦者，如附錄 II 所示。

表 3.1　　測站：鼻頭角

	量測值		推算值	
時間	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒
76/02/23:14	1.09	6.0	1.5	6.7
76/02/23:17	0.85	6.0	1.4	6.7
76/02/23:20	0.84	6.2	1.3	6.7
76/02/23:23	0.87	5.9	1.3	6.7
76/02/24:02	0.93	5.5	1.2	6.7
76/02/24:05	1.25	5.5	1.7	6.7
76/02/24:08	1.00	5.7	1.7	6.7
76/02/24:11	1.12	5.8	1.5	6.7
76/02/24:14	1.09	5.7	1.3	6.7
76/02/24:17	1.11	6.1	1.1	6.7
76/02/24:20	1.25	6.3	1.0	6.7
76/02/24:23	1.78	6.3	1.1	

表 3.2　　測站：新港

	量測值		推算值	
時　　間	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒
76/02/23:14	1.24	6.7	1.5	8.1
76/02/23:17	1.08	6.8	1.5	8.0
76/02/23:20	1.00	7.0	1.4	7.8
76/02/23:23	1.01	7.2	1.6	7.7
76/02/24:02	0.81	7.3	1.5	7.9
76/02/24:05	0.84	7.5	1.6	7.9
76/02/24:08	0.88	7.6	1.4	7.8
76/02/24:11	1.04	6.6	1.5	7.6
76/02/24:14	1.30	6.9	1.5	7.6
76/02/24:17	1.24	6.6	1.2	7.8
76/02/24:20	1.37	7.1	1.3	7.7
76/02/24:23	1.45	7.1	1.4	7.7

表 3.3　測站：東吉島

	量測值		推算值	
時間	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒
76/02/23:14	1.21	5.6	0.91	8.1
76/02/23:17	1.12	5.7	0.62	8.9
76/02/23:20	0.86	5.5	0.68	8.0
76/02/23:23	1.08	5.3	0.83	7.6
76/02/24:02	0.74	4.8	0.81	6.8
76/02/24:05	0.62	5.5	0.90	6.1
76/02/24:08	0.40	4.4	0.85	6.9
76/02/24:11	0.66	4.3	0.78	7.3
76/02/24:14	0.73	4.4	0.89	6.9
76/02/24:17	0.93	4.8	0.94	6.4
76/02/24:20	0.80	4.7	1.16	5.5
76/02/24:23	1.22	4.9	1.10	5.7

表 3.4 測站：小琉球

	量測值		推算值	
時　　間	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒	波高($H_{1/3}$)公尺	週期($T_{1/3}$)秒
76/02/23:14	0.68	4.8	0.55	6.1
76/02/23:17	0.83	4.5	0.44	5.9
76/02/23:20	0.80	4.5	0.5	6.0
76/02/23:23	0.57	4.8	0.5	5.8
76/02/24:02	0.64	4.4	0.5	5.8
76/02/24:05	0.70	4.0	0.6	5.7
76/02/24:08	0.61	4.3	0.6	5.6
76/02/24:11	0.58	3.8	0.6	5.6
76/02/24:14	0.85	3.7	0.6	5.6
76/02/24:17	1.03	4.2	0.6	5.6
76/02/24:20	0.72	4.5	0.7	5.6
76/02/24:23	0.51	4.4	0.6	5.6

表 3.5 各測站之經驗常數

測站＼常數	ξ 值	C_1	C_2	C_3	C_4
鼻頭角	0.29E − 04	0.42E + 00	0.29E − 05	0.13E + 00	0.21E − 05
新 港	0.26E − 04	0.26E + 00	0.59E − 05	−0.59E − 01	0.31E − 05
東吉島	0.24E − 04	− 0.12E − 00	0.74E − 05	−0.54E + 00	0.45E − 05
小琉球	0.96E − 05	0.13E + 00	0.53E − 05	−0.18E + 00	0.28E − 05

四、颱風湧浪週期推算法之探討

梁　乃　匡

4－1 引言

梁乃匡（1982）曾提出一個颱風湧浪預報法，其主要觀念是把颱風波浪場當作點波源來看，颱風中心波浪由 Bretschneider 方法估計（1976）。推算公式如下：

$$H_{1/3} = C \quad H_R^* \sqrt{\frac{R}{DD}} \qquad (4-1)$$

其中

$H_{1/3}$ 颱風湧浪代表波波高，單位米

C 經驗常數，約 0.11

H_R^* 移動颱風在最大風速半徑 R 處風向指向測站處的代表波高，單位呎

R 最大風速半徑，單位浬

DD 颱風中心到測站的距離，單位浬

$$T_{1/3} = C' \, T_{RS} \qquad (4-2)$$

其中

$T_{1/3}$ 颱風湧浪代表波週期，單位秒

T_{RS} 在 Bretschneider 方法中與 H_R^* 有關的颱風波浪週期，單位秒

C' 經驗常數，由下式求得：

$$C' = 0.05 \frac{DD \cdot T_{RS}}{R \cdot U_{RS}^*} + 1 \qquad (4-3)$$

其中

U_{RS}^* 爲移動颱風的海面上 10 米高 10 分鐘平均風速，單位節

（4－3）式後來被梁乃匡及簡仲璟（1984）由相同資料修改爲下式：

$$C' = 0.0021 \left(\frac{DD \cdot T_{RS}}{R \cdot U_{RS}^*}\right)^2 + 0.0012 \left(\frac{DD \cdot T_{RS}}{R \cdot U_{RS}^*}\right) + 1.21 \qquad (4-4)$$

彭海鯤（1985）建議用 $\frac{(DD \cdot T_{RS})^{1/2}}{(R \cdot U_{RS}^*)^2}$ 代替 $\frac{DD \cdot T_{RS}}{R \cdot U_{RS}^*}$ 作爲參數來求 C'，然而前者非爲無因次，在因次分析上無意義。

由於湧浪週期影響湧浪抵達的時間及由於堆積與消退所造成的波高修正係數 λ，而過去湧浪週期推算結果不盡理想，有進一步探討的必要。

4－2 新的無因次參數

如上所述，目前 $T_{1/3}/T_{RS}(=C')$ 與 $\frac{DD \cdot T_{RS}}{R \cdot U_R{}^*{}_S}$ 被用來作爲預測湧浪週期的無因次參數，表面上看 $T_{RS}/U_R{}^*{}_S$ 爲非無因次，但因波相速度 C 與週期 T_{RS} 成正比，所以 $T_{RS}/U_R{}^*{}_S$ 也是無因次的，然而， $T_{1/3}/T_{RS}$ 與 $\frac{DD \cdot T_{RS}}{R \cdot U_R{}^*{}_S}$ 均有 T_{RS} ， 這並非一個好的安排。因爲最大風速半徑 R 在計算 T_{RS} 與 $U_R{}^*{}_S$ 時已經用上，所以 R 可以去掉，如此剩下 $T_{1/3}$，T_{RS}，DD 與 $U_R{}^*{}_S$ 四個物理量，很容易就配出兩組新的無因次參數來： $T_{1/3}/U_R{}^*{}_S$ 與 $DD/T_{RS}{}^2$及 $T_{1/3}/T_{RS}$ 與 $DD/U_R{}^*{}_S{}^2$ 前者的物理意義是湧浪波速與颱風中心最大風速的比值，及代表颱風中心與測站間波長的倍數。後者表示湧浪週期與風浪週期之比及代表測站與颱風中心距離的無因次長度（分子應乘重力加速度 g ，因係常數故省略）。

因爲在觀念上假設颱風波浪場爲一點波源，所以由颱風移動而造成在颱風波浪場的變化也許不重要，因此未考慮颱風移動的 T_R 與 U_{RS} 可以取代 T_{RS}與$U_R{}^*{}_S$，如此則有（ $T_{1/3}/T_R$ ，$\frac{DD \cdot T_R}{R \cdot U_R{}^*{}_S}$），（$T_{1/3}/T_R$ ，$\frac{DD \cdot T_R}{R \cdot U_{RS}}$），（ $T_{1/3}/T_R$ ，$\frac{(DD \cdot T_R)^{1/2}}{(R \cdot U_R{}^*{}_S)^2}$），（ $T_{1/3}/U_R{}^*{}_S$，$\frac{DD}{T_R{}^2}$ ），（$\frac{T_{1/3}}{T_R}$ ，$\frac{DD}{U_{RS}{}^2}$ ），（$\frac{T_{1/3}}{U_{RS}}$，$\frac{DD}{T_R{}^2}$） 六組參數對可供選擇，很幸運的， 1985—1986 兩年間在蘇澳測得 8 個颱風的湧浪，這 8 個颱風的資料如附錄 III 的表中，相關的波浪資料在附錄 IV 的表中。

上述六組參數將利用實測資料作其相關性分析，相關性最大的就是最好的參數。今有 A 、 B 兩隨機變數，其相關係數（Correlation Coefficient）的定義如下：

$$\text{Correlation Coefficient} = \frac{Cov\{A, B\}}{\sigma_A \cdot \sigma_B} \qquad (4-5)$$

其中 σ_A 與 σ_B 爲 A與 B 的標準偏差，相關係數的絕對值永遠小於 1 ，對 N 個有限資料而言，

$$\text{Correlation Coef} = \frac{\sum_1^N (A-\bar{A})(B-\bar{B}) / (N-1)}{\left(\frac{\sum_1^N (A-\bar{A})^2}{N-1}\right)^{1/2} \left(\frac{\sum_1^N (B-\bar{B})^2}{N-1}\right)^{1/2}}$$

$$= \frac{\sum_1^N (A-\bar{A})(B-\bar{B})}{\left(\sum_1^N (A-\bar{A})^2\right)^{1/2} \left(\sum_1^N (B-\bar{B})^2\right)^{1/2}} \qquad (4-6)$$

其中$\overline{A}$與$\overline{B}$為A與B的平均值。

找尋颱風與其相關的波浪資料的方法，如同以往一樣由$T_{1/3}$的群波速度，即 1.56 $T_{1/3}$節來追溯颱風中心的位置，如非恰好相等，則以內插法求出$T_{1/3}$。由於吾人相信湧浪週期$T_{1/3}$必然大於颱風中心風浪週期T_R或T_{RS}，因此當得到的$T_{1/3}$小於T_R或T_{RS}則捨去，因為湧浪很可能被當地短週期風浪所“污染”而變小。另外，當距離誤差在50浬以上者亦捨去。由8個颱風一共採集了69個樣品，求得的相關係數如表4－1所示，以（$T_{1/3}/U_{RS}$，DD/T_R^2）的相關最好。

表 4 — 1 各參數間相關係數

參　　數	相關係數
$\frac{T_{1/3}}{T_R}$ & $\frac{DD\cdot T_R}{R\cdot U^*_{RS}}$	0.305
$\frac{T_{1/3}}{T_R}$ & $\frac{DD\cdot T_R}{R\cdot U_{RS}}$	0.316
$\frac{T_{1/3}}{T_R}$ & $\frac{(DD\cdot T_R)^{1/2}}{(R\cdot U_{RS})^2}$	0.55
$\frac{T_{1/3}}{U^*_{RS}}$ & $\frac{DD}{T_R^2}$	0.485
$\frac{T_{1/3}}{T_R}$ & $\frac{DD}{U_{RS}^2}$	0.514
$\frac{T_{1/3}}{U_{RS}}$ & $\frac{DD}{T_R^2}$	0.626

用U_{RS}比U^*_{RS}要好，$\frac{T_{1/3}}{T_R}$ & $\frac{(DD\cdot T_R)^{1/2}}{(R\cdot U_{RS})^2}$為次優。

4 － 3 新的湧浪推算公式

由上節知參數對 $\frac{T_{1/3}}{U_{RS}}$ & $\frac{DD}{T_R^2}$ 的相關最高將69組資料列在表 4 － 2 ，並點繪在圖 4 － 1 ，資料點仍然很散，其原因很可能是部份湧浪被當地短週期波浪所“汚染”而變小所致，因此最好由波譜求出湧浪週期來取代波週期 $T_{1/3}$。在圖 4 － 1 上的資料點中取兩條曲線。其一取包絡線，假設較大值的資料未被當地風浪所“汚染”，代表眞正的湧浪週期，其二取中間值，假設無上述情況。

因 $\frac{DD}{T_R^2}$ 大於20者很少，因此假設 $\frac{DD}{T_R^2} > 20$ 時 $\frac{T_{1/3}}{U_{RS}}$ 取常數。迴歸出二方程式如下：

表 4 — 2 無因次參數原始資料

颱風名	年	月	日	時	$T_{1/3}$ ／ U_{RS}	DD ／ T_R^2	註
HAL	1985	6	20	8	0.32	12.1	
				14	0.29	9.8	
				20	0.28	8.5	
			21	2	0.29	7.7	
				8	0.26	6.2	
				14	0.24	5.4	
				20	0.23	4.2	
IRMA	1985	6	27	14	0.33	11.4	
				20	0.27	9.1	
			28	2	0.21	7.5	
NELSON	1985	8	18	20	0.33	16.5	
			19	2	0.27	12.9	
				8	0.27	11.8	
				14	0.28	11.2	
				20	0.25	9.4	
			20	2	0.25	8.7	
				8	0.26	8.1	

				14	0.23	7.0
			21	2	0.23	5.9
				8	0 23	5.3
				14	0.22	4.2
				20	0.22	3.6
			22	2	0.21	2.7
				8	0.22	2.2
				14	0.23	1.6
				20	0.22	1.1
VERA	1986	8	15	8	0.52	15.9
				14	0.39	12.8
				20	0.41	12.5
			16	2	0.45	11.9
				14	0.36	11.7
				20	0.33	10.3
			17	2	0.30	10.2
				14	0.38	13.0
			18	2	0.37	15.8
				8	0.28	11.8
			23	8	0.16	9.2
				14	0.17	9.1
				20	0.18	8.5
			24	2	0.18	8.1
ABBY	1986	9	14	20	0.42	20.4
			15	2	0.44	19.2
				8	0.35	13.9
				14	0.35	12.5
			17	20	0.20	2.8
			18	2	0.20	2.4
				8	0.21	2.1

表 4－2（續）

颱風名	年	月	日	時	$T_{1/3}$ ／ U_{RS}	DD／T_R^2	註
BRENDA	1985	10	1	20	0.26	9.8	
			2	8	0.28	8.1	
				14	0.29	7.3	
				20	0.33	6.6	
			3	2	0.35	5.7	
				8	0.29	3.7	
				14	0.27	2.7	
				20	0.27	1.9	颱風接近
			4	2	0.29	1.2	〃
				8	0.23	0.6	〃
				14	0.22	1.0	〃
DOT	1985	10	14	8	0.43	31.5	
				14	0.38	26.7	
				20	0.27	18.8	
			15	2	0.27	17.8	
				8	0.20	13.0	
SARAH	1986	7	31	20	0.44	14.1	
		8	1	2	0.31	10.1	
				8	0.42	12.1	
				14	0.39	10.6	
				20	0.39	10.0	
			2	2	0.39	9.9	

包絡線

$$\frac{T_{1/3}}{U_{RS}} = 0.2 + 0.023\frac{DD}{T_R^2} - 0.0005\frac{(DD)^2}{T_R^4}, \quad \frac{DD}{T_R^2} \leq 20$$

(4-7)

$$\frac{T_{1/3}}{U_{RS}} = 0.46 \qquad \frac{DD}{T_R^2} > 20$$

中間值曲線

$$\frac{T_{1/3}}{U_{RS}} = 0.18 + 0.0155\frac{DD}{T_R^2} - 0.00025\frac{(DD)^2}{T_R^4}, \quad \frac{DD}{T_R^2} \leq 20$$

(4-8)

$$\frac{T_{1/3}}{U_{RS}} = 0.39 \qquad \frac{DD}{T_R^2} > 20$$

4－4 驗證

採取 1980年五個颱風 － IDA, KIM, NORRIS, PERCY 及 BETTY ，用式（4－7）及（4－8）推算湧浪週期，再與在南灣用壓力式波高計所測週期比較，點繪於圖 4－2， 4－3上，（其中當 $T_{1/3}$ 小於 T_R即令 $T_{1/3} = T_R$），由圖看出除了另有原因外，由包絡線方程式（式（4－7））所算出的值與實測值比較吻合。

4－5 結論

(1) $\frac{T_{1/3}}{U_{RS}}$ 與 $\frac{DD}{T_R^2}$ 爲最佳的無因次參數，由 8 個颱風， 69 組資料，取包絡線迴歸求得經驗式如下：

$$\frac{T_{1/3}}{U_{RS}} = 0.2 + 0.023\frac{DD}{T_R^2} - 0.0005\frac{(DD)^2}{T_R^4}, \quad \frac{DD}{T_R^2} \leq 20$$

$$\frac{T_{1/3}}{U_{RS}} = 0.46 \qquad \frac{DD}{T_R^2} > 20$$

經與實測資料比較，頗爲吻合。

(2)一般實測波浪資料湧浪與當地風浪混在一起，因此實際湧浪週期應大於 $T_{1/3}$ 。所以，以後應計算波譜，求出湧浪週期代替 $T_{1/3}$。

(3)當颱風太近時，本方法已不能應用。

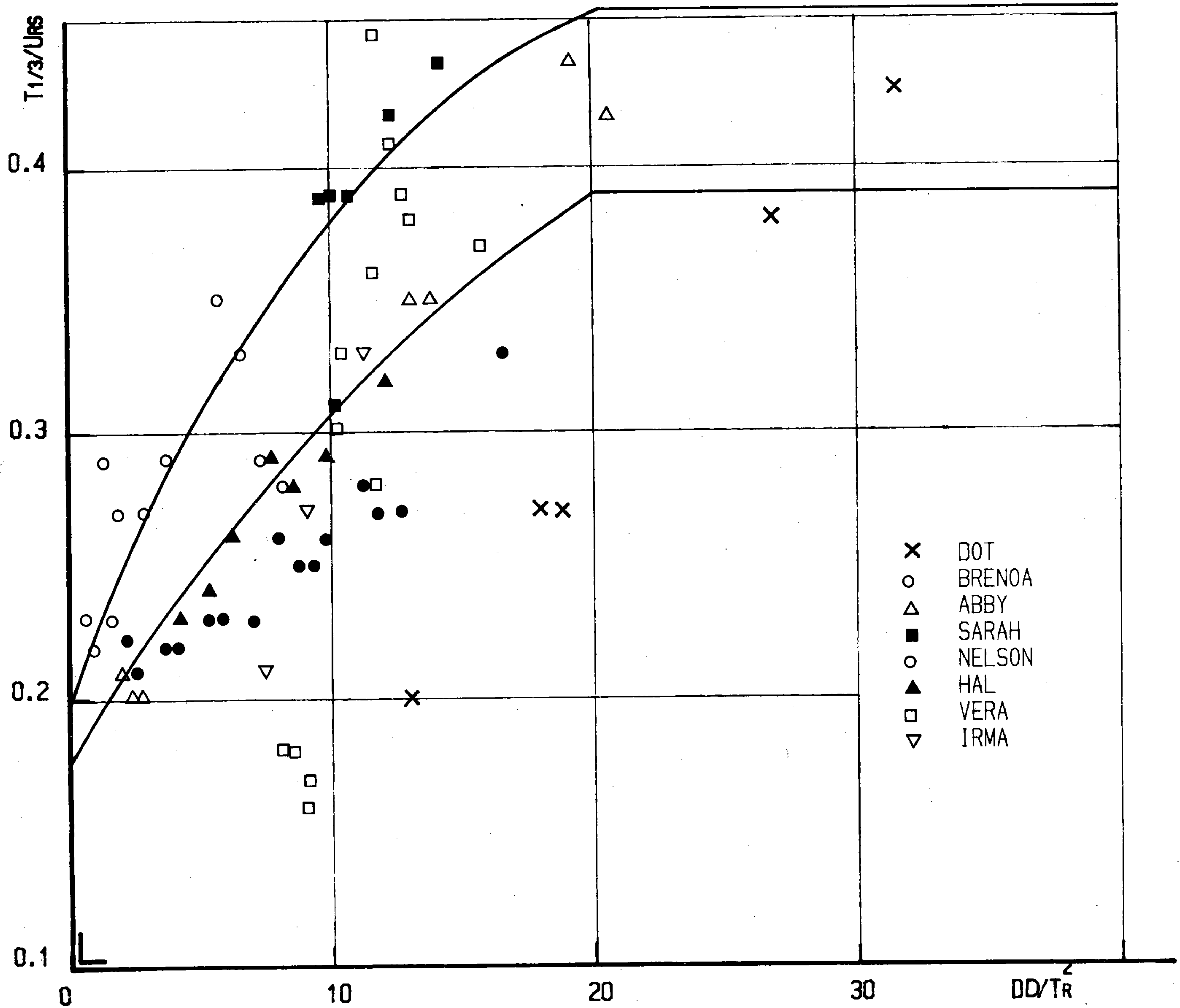


圖4-1 $T_{1/3}/U_R$ 對應 DD/T^2 圖

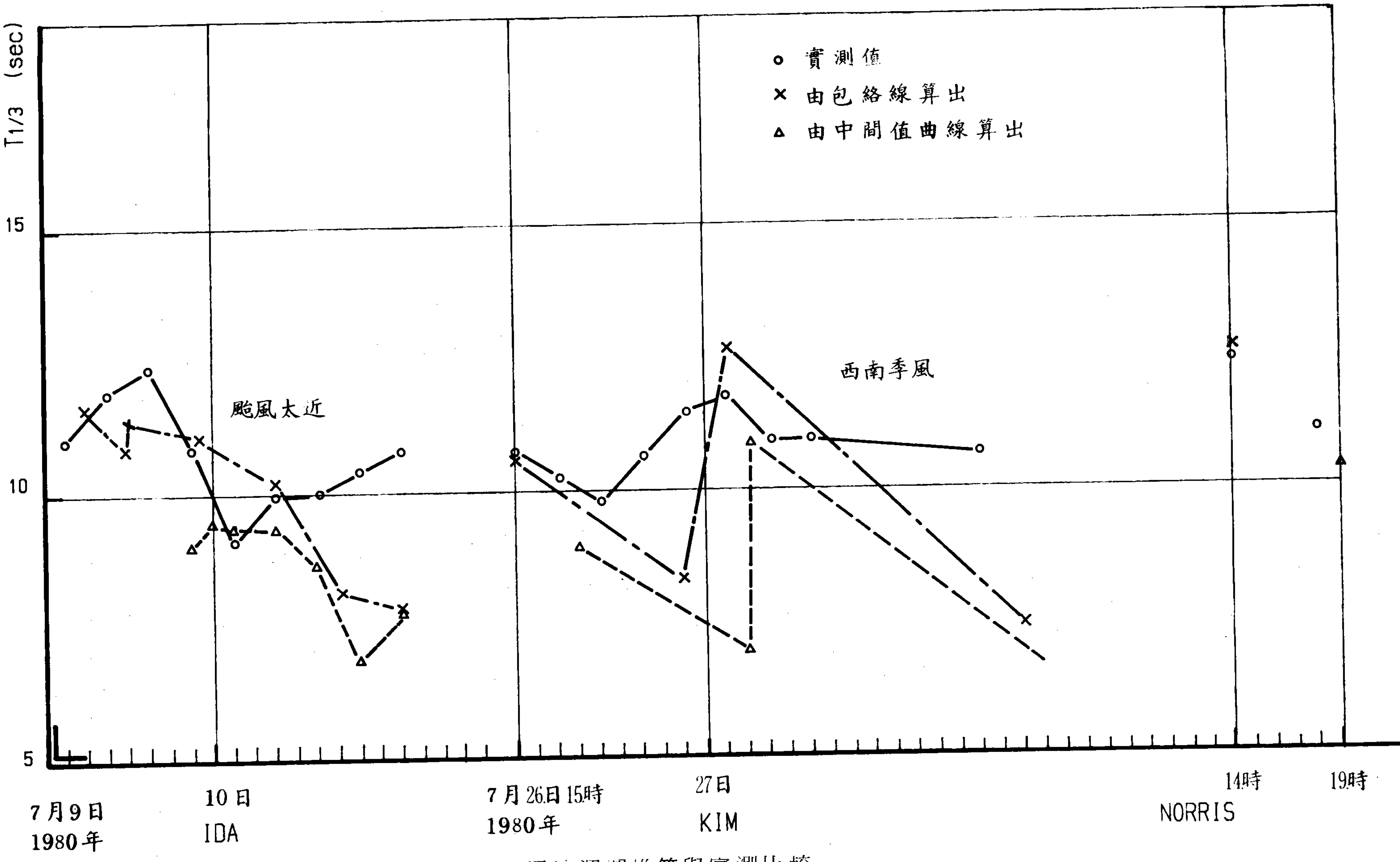


圖 4 － 2　湧浪週期推算與實測比較

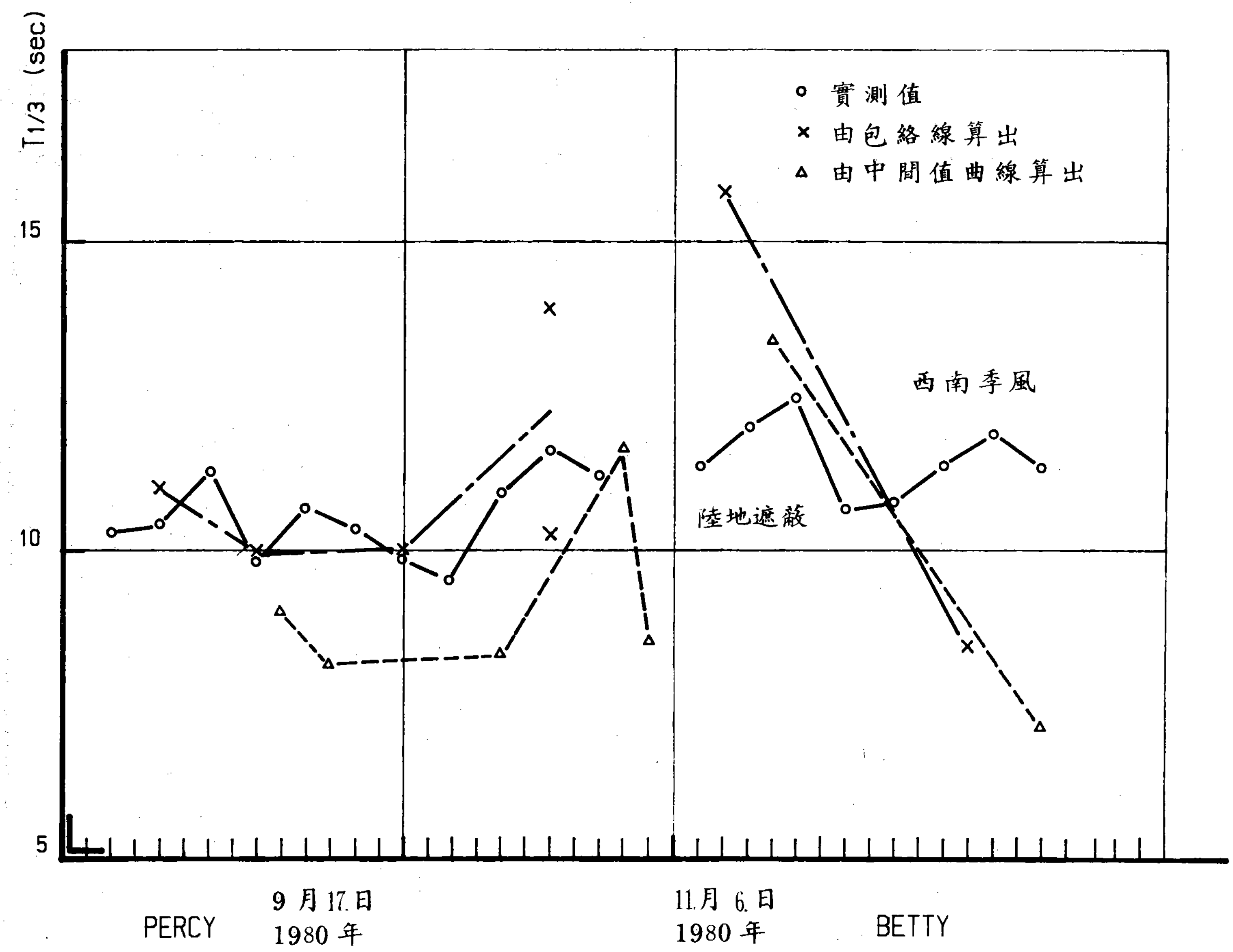


圖 4 — 3　湧浪週期推算與實測比較(續)

五、等效風域法颱風波浪之推算

吳　基

1. 引　言

所謂等效風域法在基本上是應用 Bretschneider 在 1979 年發表的 " The Two - Direction Significant Wave Forecasting Model With Special Application to U.S. Weather Service Hurricane Wind Model " 中各個基本公式，而以等效風域之觀念推算颱風風場內波浪場之狀況，有關各個基本公式及相關圖表、常數，請直接參閱該文，在此不多贅述。

2. 等效風域（ Equivalent Fetch ）法之原理

由於穩定颱風係屬一種滯留，穩定狀態之風場，故其波浪場分佈的情形僅爲半徑 r 之函數，由最大風速半徑處往外，波高逐漸遞減（註：依照Bretschneider 之推算，在 2 R 處，可能有較大之代表波高出現），故我們可以由最大風速半徑R處往外，延半徑方向繪一直綫至外圍圓周，如能計算出此綫上各點之代表波高分佈，則穩定颱風風場內任一點之波浪分佈均能推得。

現說明等效風域法之原理如下：

假設一條直綫上各點之風速、風向、兩點間之距離均爲已知，如圖 5 － 1 所示，則 B 點之代表波高 H_B 可由 A 點之風速延此綫之分量與吹風距離（此時爲 $\triangle_X$ ）所決定，卽

$$\frac{gH_B}{U_A U_A \mathrm{Cos}(\alpha_A)} = 0.283 \tanh \left[0.0125 \left(\frac{g\triangle_X}{U_A U_A \mathrm{Cos}(\alpha_A)} \right)^{0.42} \right]$$

得出 H_B 之後，再利用同樣的式子，以 U_B 取代 U_A ，α_B 取代 α_A ，$\triangle_X$ 則以 F_{AB} 代替，則可反求出 F_{AB}

$$F_{AB} = \frac{U_B U_B \cos(\alpha_B)}{g} \cdot \left[\frac{1}{0.0125} \tanh^{-1} \left(\frac{gH_B}{0.283 U_B U_B \cos(\alpha_B)} \right) \right]^{\frac{1}{0.42}}$$

此處之 F_{AB} 卽代表在同樣波高之前題下，以B 點之風取代 A點之風所得之等效風域（Equivalent Fetch ）。

接下來欲求 C 點之代表波高 H_C 則可用 B 點之風 U_B 及有效風域（此時爲 $\triangle_X + F_{AB}$）代入基本公式(1)而得，而 H_C 又可以 C 點之風 Uc 代回原式得出等效風域 F_{AC} ，依次類推則 B 、C 、D 、E 、F 各點之代表波高均可推得

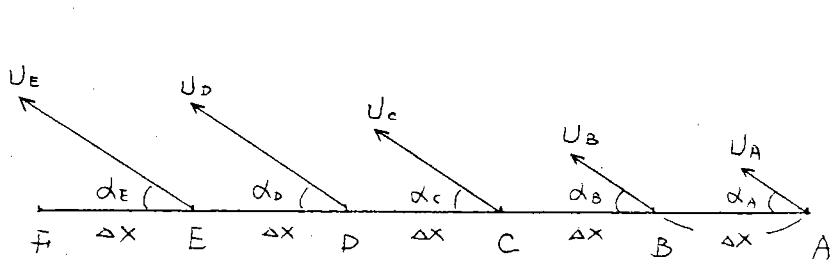


圖 5 － 1 等效風域之推算原理

3. 推算之步驟

依據 Bretschneider之經驗公式，在XY座標平面上任一點之波高均可由X方向上來的分量 H_X 及Y方向上來的分量 H_Y 以能量疊加之方式合成，即 $HH=(H_X{}^2+H_Y{}^2)^{1/2}$，故實際推算步驟如下：

①繪出代表穩定颱風之圓形風場，以圓心爲原點 0，決定X、Y軸得到四個象限，預定用於推算之象限爲第四象限。

②延＋X軸及－Y軸，自 1 R開始至NR 爲止，以R／5爲間隔等分成5 N段，（N可自行設定，若定爲14，表示風場邊緣定於 14 R處根據實際推算之結果顯示，N之值定爲 10 至 14 較爲適宜參見圖 5 － 2），並繪成網格點，圖 5 － 3 是一個簡化了的圖形，僅分割成 5 段，實際推算時X、Y軸上各有50.～70.段。

③將模式颱風或實測颱風之重要氣象參數輸入，並利用基本公式推算X軸上各點之風速U(IC, 1)（IC ＝ 5N, 5N－1, …… 5　IC ＝ 5 時，即爲最大風速半徑處）。

④由X軸上最外點向內，依等效風域之觀念依序推算各點之 H_X（$H_{1/3}$之 X軸方向上分量）即 $H_X(IC-1, 1) \Rightarrow H_X(IC-2, 1) \Rightarrow \cdots\cdots \Rightarrow H_X(5, 1)$。

⑤利用三角函數關係計算正交於X軸上各點之Y軸平行線上各網格點之位置角（θ），距圓心距離，風向與Y軸平行線之夾角，並推算出各點之風速。

⑥依等效之風域之觀念，由Y軸平行線上圓周之點向上逐步推算出各點之 H_Y（$H_{1/3}$在Y軸平行線上之分量）直到抵達X軸爲止。

$$H_Y(IC, ID) \Rightarrow H_Y(IC, ID-1) \Rightarrow \cdots\cdots \Rightarrow H_Y(IC, 1)$$

⑦將X軸上各點所得之 $H_X(IC, 1)$ 與 $H_Y(IC, 1)$合成，即

$$HH(IC, 1)=\sqrt{H_X(IC, 1)^2+H_Y(IC, 1)^2} \quad . \quad IC=5N-1, 5N-2, \cdots 5$$

⑧以此推算所得之穩定颱風颱風波浪場爲基本架構，考慮颱風移動方向及速度，則可推算出移動風場內任一點之代表波波高狀態。

一般而言，移動颱風與穩定颱風比較，其右半圓，波高會變大，而左側則會減小。

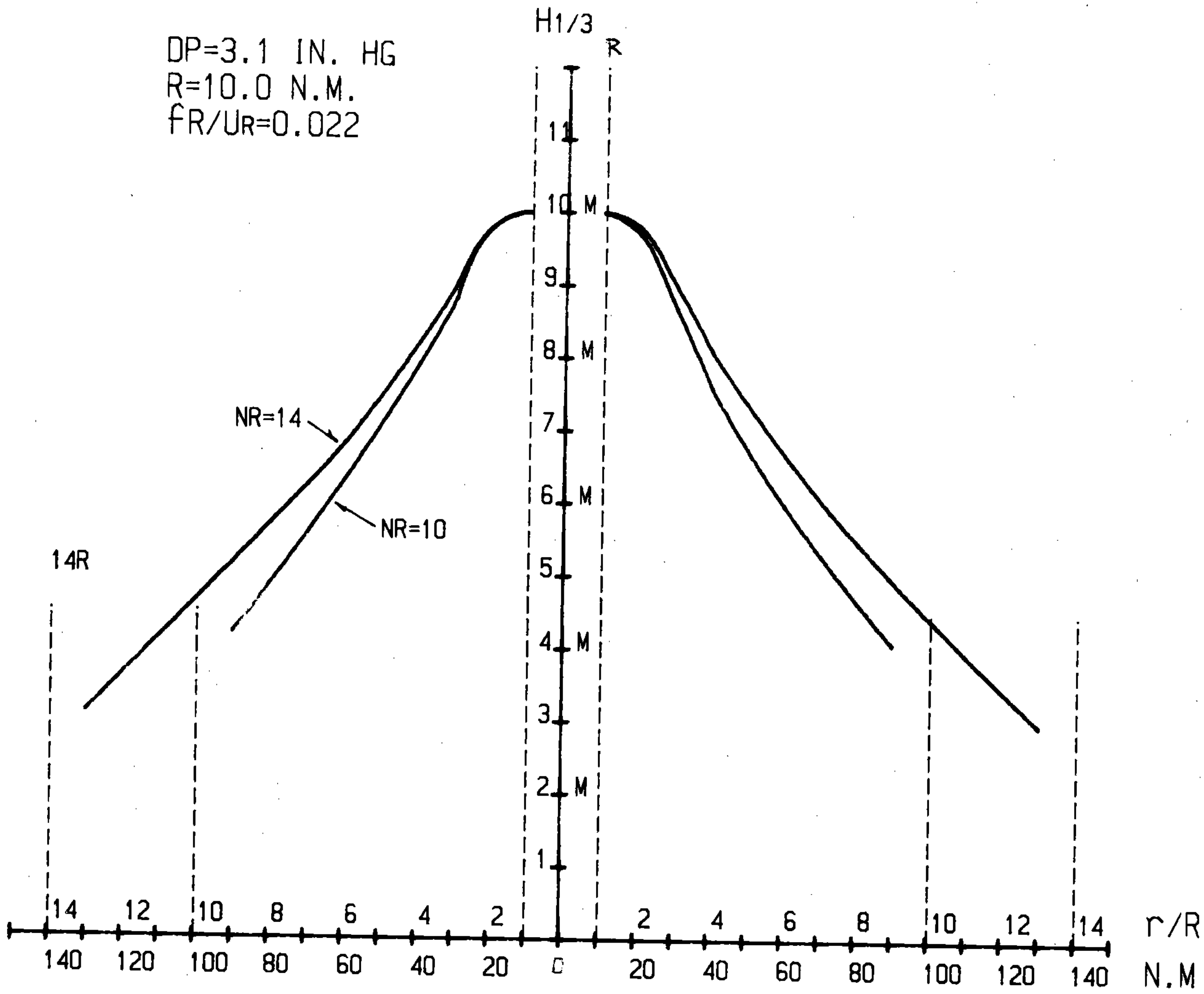


圖 5 — 2　以不同 NR 值推算穩定颱風風場內波高分佈

圖 5—3 STATIONARY HURRICANE

波浪場之推算

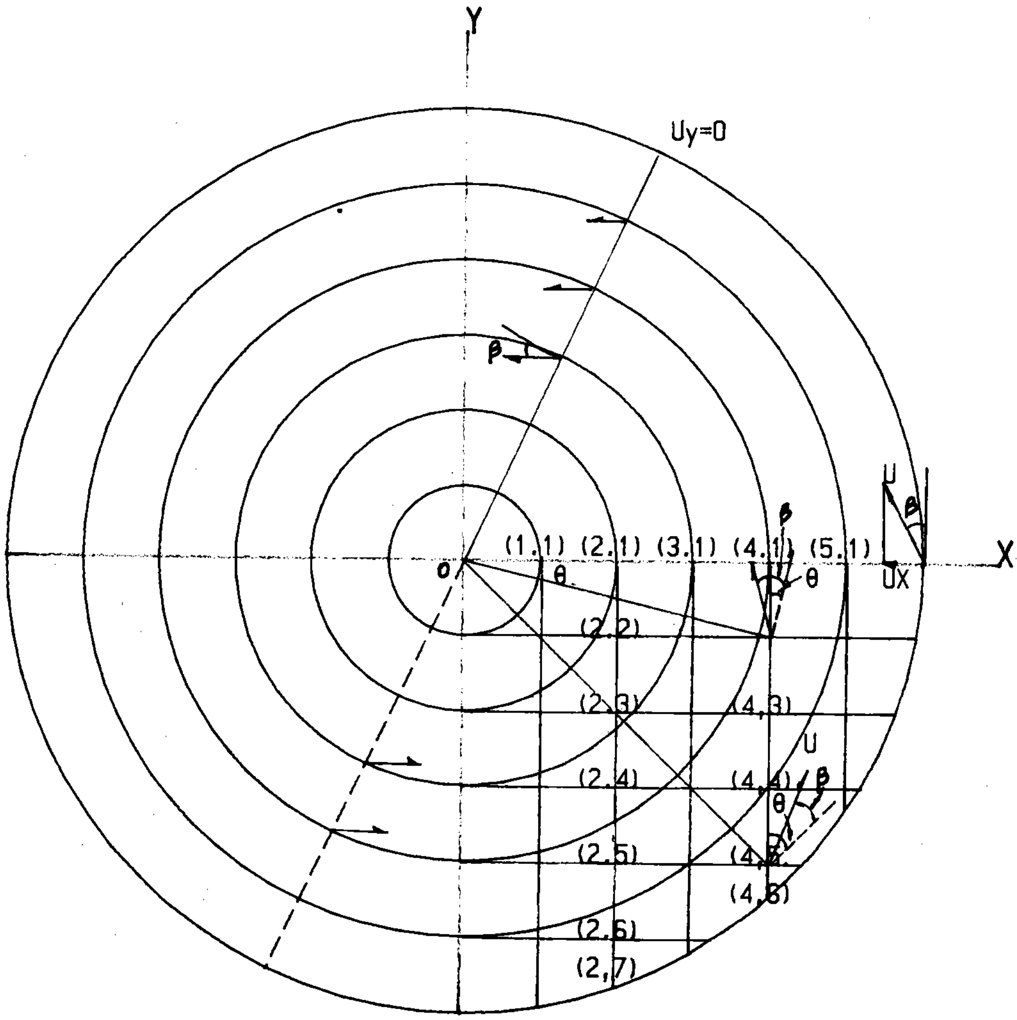
$$\frac{gHx}{UUx} = A_1 \tanh[B_1(\frac{gFx}{UUx})^{m_1}] \qquad Fx = \frac{UUx}{g}\left(\frac{1}{B_1}\tanh^{-1}\left(\frac{1}{A_1}\left(\frac{gHx}{UUx}\right)\right)\right)^{\frac{1}{m_1}}$$

$$\frac{gHy}{UUy} = A_1 \tanh[B_1(\frac{gFy}{UUy})^{m_1}] \qquad Fy = \frac{UUy}{g}\left(\frac{1}{B_1}\tanh^{-1}\left(\frac{1}{A_1}\left(\frac{gHy}{UUy}\right)\right)\right)^{\frac{1}{m_1}}$$

$$Ux = U\cos(90^\circ - \beta)$$

$$Uy = U\cos(\beta - \theta)$$

$$Hs^2 = Hx^2 + Hy^2$$



4. 推算結果

表5－1是採用數個 $\frac{fR}{U_R}$ 值不同的模式颱風依Bretschneider 法推算和用等效風域法推算所得之最大風速半徑R處之代表波高，$H_R{}^{*}{}_{COMP}$ 代表Bret－schneider法推算之數值（以下簡稱B法），HH_R 則代表等效風域推算之結果，大致來說，本法推算之數值較 $H_R{}^{*}{}_{COMP}$ 略小，約爲 $H_R{}^{*}{}_{COMP}$ 之80～90％，且由表中可看出，當 $\frac{fR}{U_R}$ 值較小時，兩者較爲接近，$\frac{fR}{U_R}$ 值變大時，兩數值之差異亦增大。

其次在全風場內波高分佈的比較可由圖5－4和圖5－5看出，圖5－4爲B法所得之 Hr/H_R 對應r／R圖，圖5－5則爲等效風域法所得之結果，兩圖之趨勢相同，但同一個 $\frac{fR}{U_R}$ 值之綫，等效風域法之結果，位置均較B法爲低，且在r／R＝2處，B法有向上凸起之最大值，等效風域法則無此現象。

爲驗證等效風域法在實際颱風波浪推算上之效果，我們選擇了數個侵襲台灣之颱風加以推算，其路徑見圖5－6，其中薇拉颱風於7月31日7點30分登陸基隆，中心氣壓爲930 mb，R值經推定爲16n.m.，移動速度爲12 節，實測波浪資料係取自位於八尺門之壓力式波高計（水深125 呎），由於水深與波長之比值爲淺水波性質，故推算之結果應乘以淺化係數 K_S 加以修正，首先假定薇拉颱風處於穩定之狀態，利用等效風域法推算之波浪場如圖5－7所示，其中左半圓係以一米爲間隔，繪出波高同心圓，右半側則以R處之波高爲100％，而繪出百分比同心圓，這個結果再配合颱風之移動效應可推得移動颱風之波浪場，結果見表5－2，表中HHr爲穩定之颱風狀態應有之波高，HHa 爲已考慮移動效應後之代表波高，HH_{KS} 則爲再經過淺化係數 K_S 修正（×0.913）後之數值。圖5－8爲八尺門波浪測站實測資料與推算值之比較，在颱風接近期間，等效風域法之推算值最接近實測值，兩者幾乎重合，1630至1810這段時間，測站位於颱風最大風速半徑R內，無論是Bretschneider 法或等效風域法均無法預測波高狀況，至於實測資料則顯示最大代表波高爲40.9呎，在颱風離去期間，圖上顯示推算值均大于實測值，此現象事實上相當合理，因颱風登陸後風場結構已受破壞，且測站位于陸地邊緣，風域受到陸地限制顯著變小，故以穩定颱風爲基本架構而推算之波浪自然應當偏大。

至於另外兩個颱風NINA 及BRENDA之推算結果並不理想（參見圖5－9及圖5－10 ）以NINA 颱風而論，B法及等效風域法推算值均較實測值爲大。由於實測資料係取自於其它論文所載，測站之位置與水深等特性是否有特殊之處，有待查考，單以推算結果而言B法之誤差較大。至於BRENDA 颱風則等效風域及B法推算值均遠低於實測值。且等效風域法數值最低。由圖5－6可看出BRENDA 颱風之路徑係於距測站相當距離外掠過，因此波高成份中必有相當大之湧浪在內，相信這是實測波高偏大之主要因素。

No.	$\frac{f_R}{U_R}$	緯度 ϕ	$f=0.525 \times \sin\phi$	R (n.m)	U_R (knots)	K	ΔP (IN.Hg)	$R\Delta P$	K'	$H_R^*=K'\sqrt{R\Delta P}$	$H_R^*{}_{COMP}$ (M.)	HH_R (M.)	$HH_R/H_R^*{}_{COMP}$
2	0.0	0°	0.0	10	110.7	70	2.5	25	7.50	11.4	11.1	10.0	0.90
3	0.0	0°	0.0	25	99.0	70	2.0	50	7.50	16.1	14.0	12.4	0.88
6	0.025	30°	0.2625	10	104.1	66.0	2.55	25.5	6.54	10.1	10.4	8.7	0.83
7	0.025	22°	0.2009	14	112.3	67.0	2.88	40.3	6.55	12.6	13.0	10.9	0.84
8	0.025	11°	0.1002	25	102.4	68.5	2.29	57.3	6.56	15.1	14.3	12.2	0.85
10	0.05	28°	0.2465	15	74.6	67	1.3	19.5	5.81	7.8	7.6	6.5	0.86
11	0.05	22°	0.1967	20	80.1	67	1.5	30.0	5.85	9.8	9.7	8.0	0.83
15	0.10	22°	0.1967	40	80.0	67	1.57	62.8	5.01	12.1	11.9	9.8	0.83
20	0.15	35°	0.3011	35	70.0	66	1.30	45.5	4.50	9.3	9.4	7.6	0.81
24	0.20	35°	0.3011	40	60.0	66	1.00	40.0	4.10	7.9	7.9	6.4	0.81
26	0.20	41°	0.3444	40	67.5	63.8	1.36	54.4	4.10	9.3	9.3	7.4	0.80
39	0.30	35°	0.3011	65	64.9	66.0	1.28	83.2	3.55	9.8	10.0	8.1	0.81

表 5－1　以 *Bretschneider* 法及等效風域法推算穩定颱風最大風速半徑R處之代表波高之比較

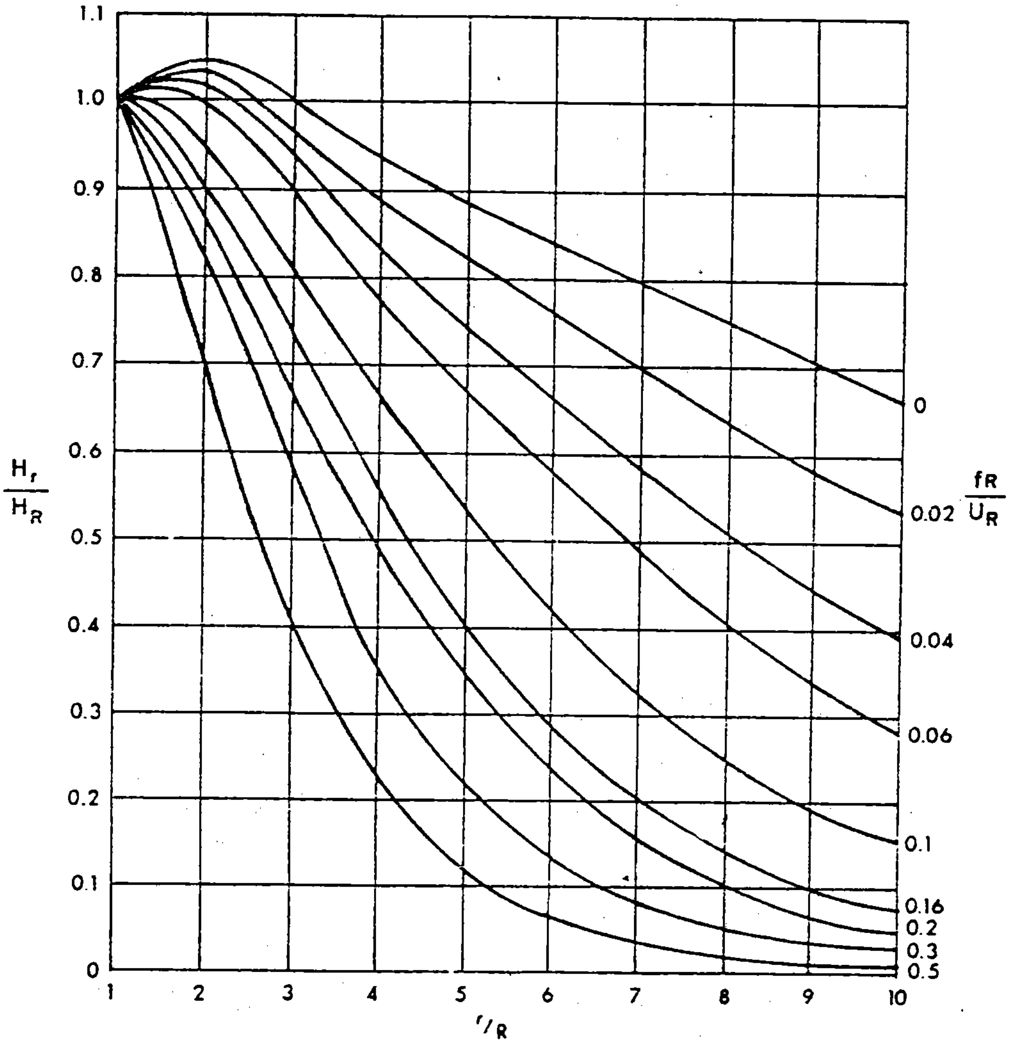


圖 5 — 4　以 Bret 法推算不同 $\frac{fR}{U_R}$ 值之颱風波浪場之分佈

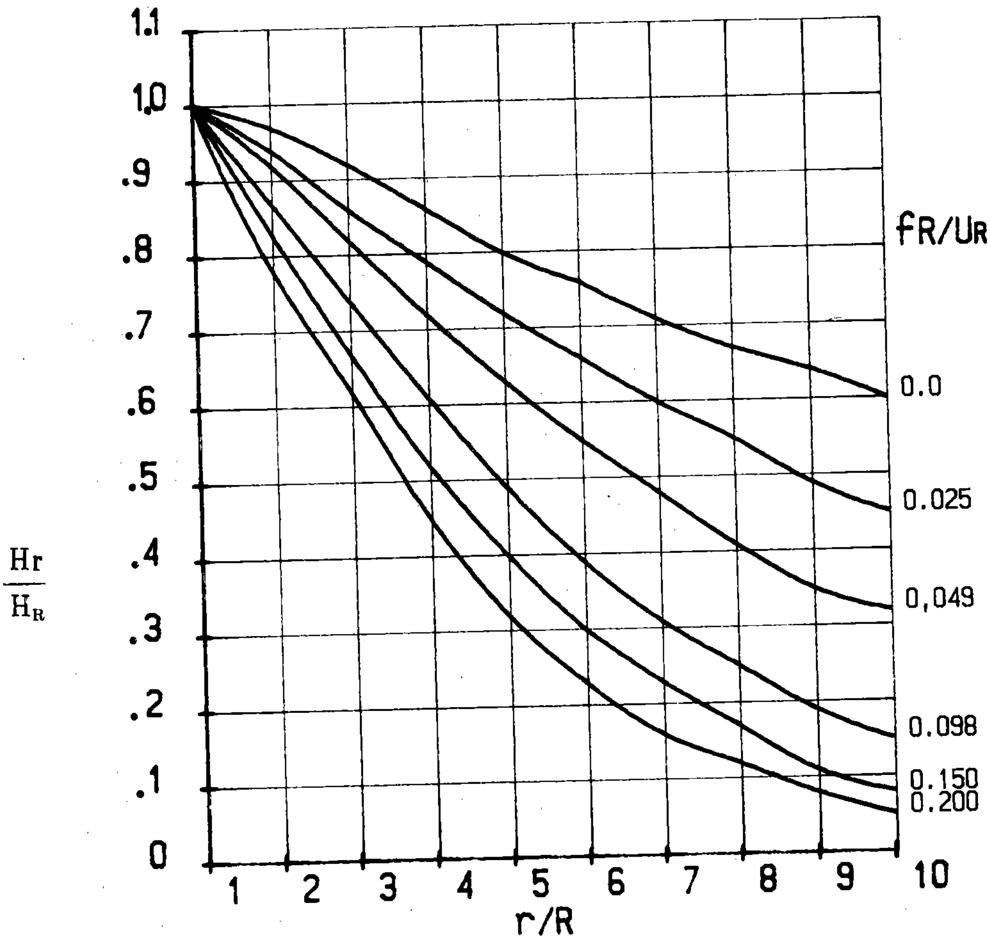


圖 5 — 5　以等效風域法推算不同 $\frac{fR}{U_R}$ 值之

颱風波浪場之分析

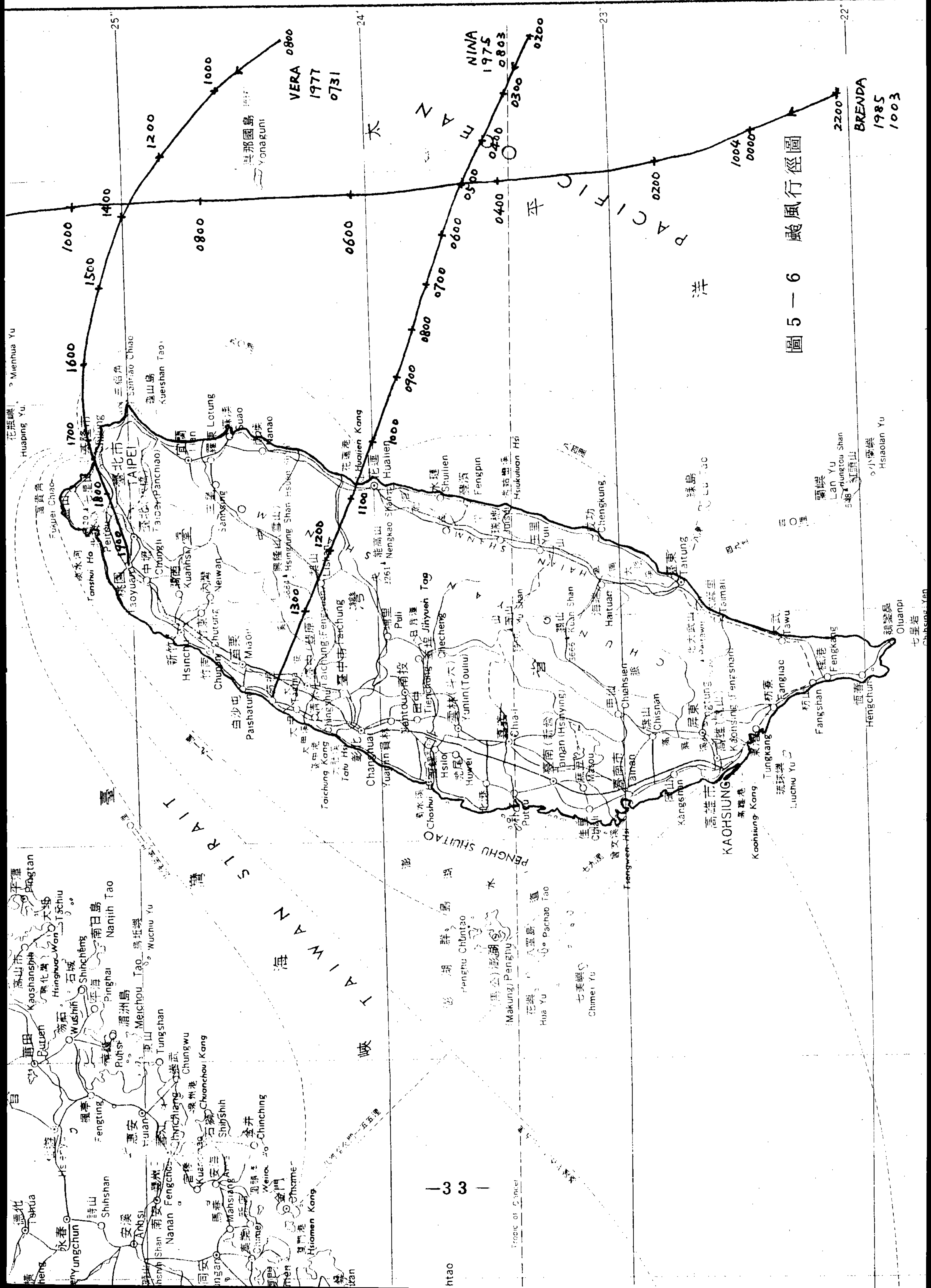

VERA
1977
0731
NINA
1975
0803
BRENDA
1985
1003
TAIPEI
KAOHSIUNG
TAIWAN STRAIT
PACIFIC
臺灣海峽
太平洋

圖5－6 颱風行徑圖

	LOCAL TIME	氣壓 (mb)	$\theta°$	$cos(\theta+\beta)$	V_a $(knots)$	DR $(n.m.)$	DR/R	ΔU	$(1+\frac{\Delta U}{U_{RS}})^2$	HHr (M.)	HHa (M.)	$HHks$ (M.)
7/31	11	930	115	−0.77	10	86	5.37	−3.85	0.85	6.5	5.5	5.02
	12	930	110	−0.71	10	76	4.75	−3.55	0.87	6.9	6.0	5.5
	13	930	100	−0.57	10	68	4.25	−2.85	0.91	7.3	6.6	6.1
	14	930	100	−0.57	12	58	3.63	−3.42	0.90	7.9	7.1	6.5
	15	930	98	−0.54	12	42	2.63	−3.24	0.92	8.8	8.1	7.4
	16	930	95	−0.5	12	24	1.5	−3.0	0.93	9.6	8.9	8.1
	17	930	90	−0.42	12	78	0.5	—	—	—	—	—
	18	935	270	0.42	11	78	0.5	—	—	—	—	—
	19	940	270	0.42	11	21	1.31	2.3	1.05	9.4	9.8	8.9
	20	950	285	0.64	11	38	2.4	3.5	1.1	8.6	9.4	8.6

表　5－2 薇拉（VERA）颱風通過期間，八尺門測站代表波高推算表

註：$\beta=25°$　θ 為測站之位置角，如以 Y 軸表颱風行進方向，θ 角為由 X 軸開始反時針計算

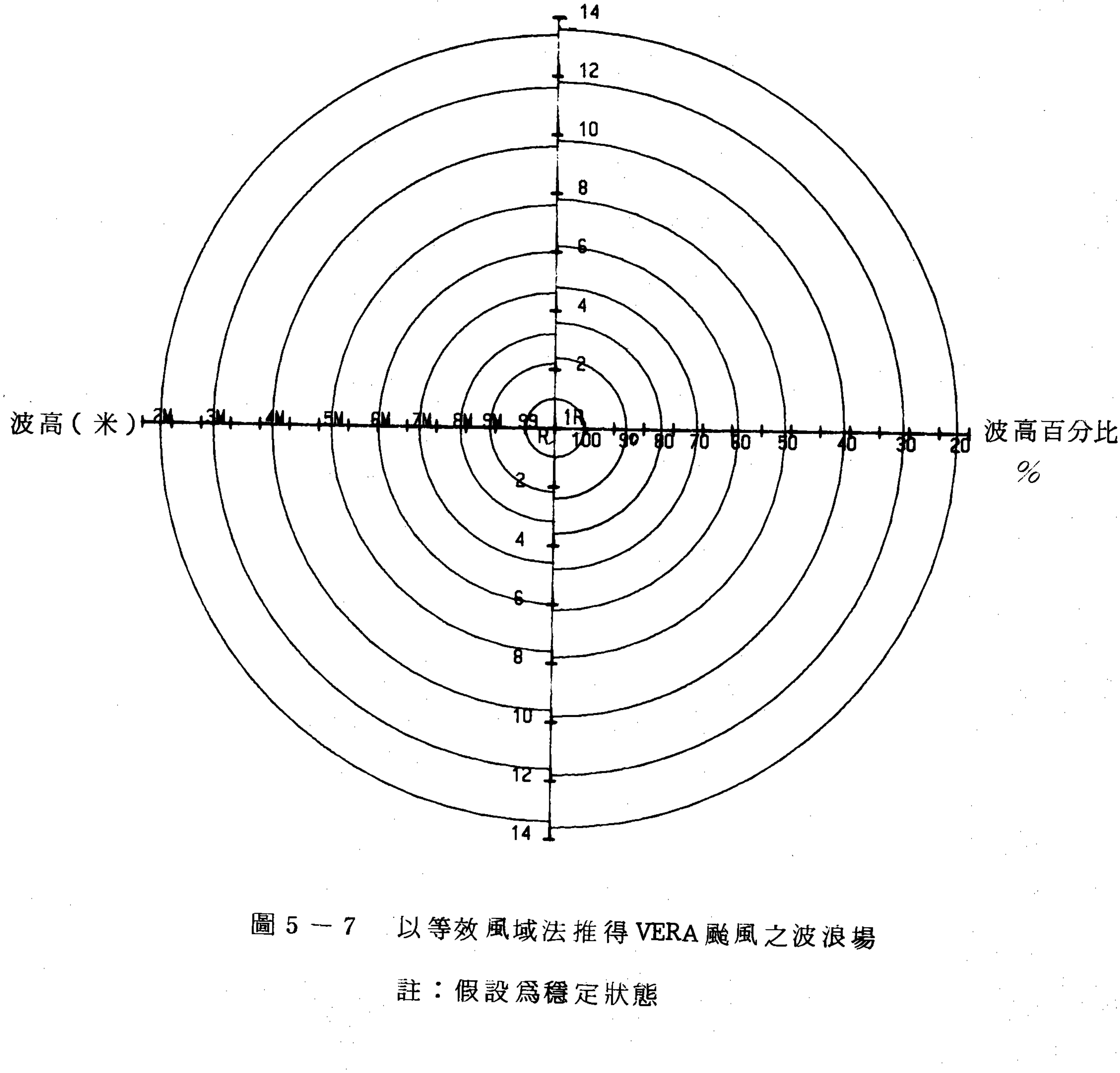


圖 5 － 7　以等效風域法推得 VERA 颱風之波浪場

註：假設爲穩定狀態

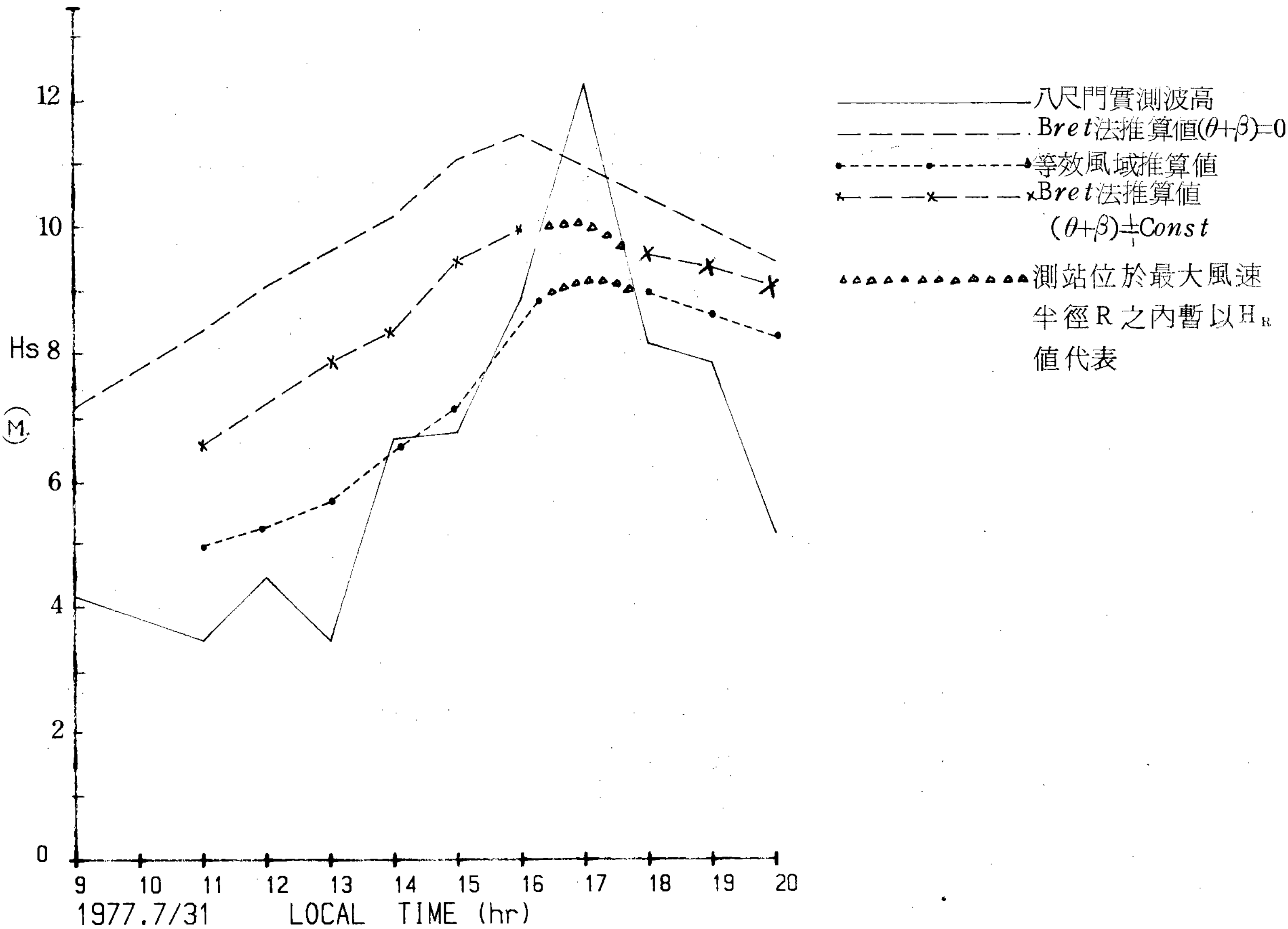


圖 5 — 8 薇拉颱風實測與推算代表波高之比較

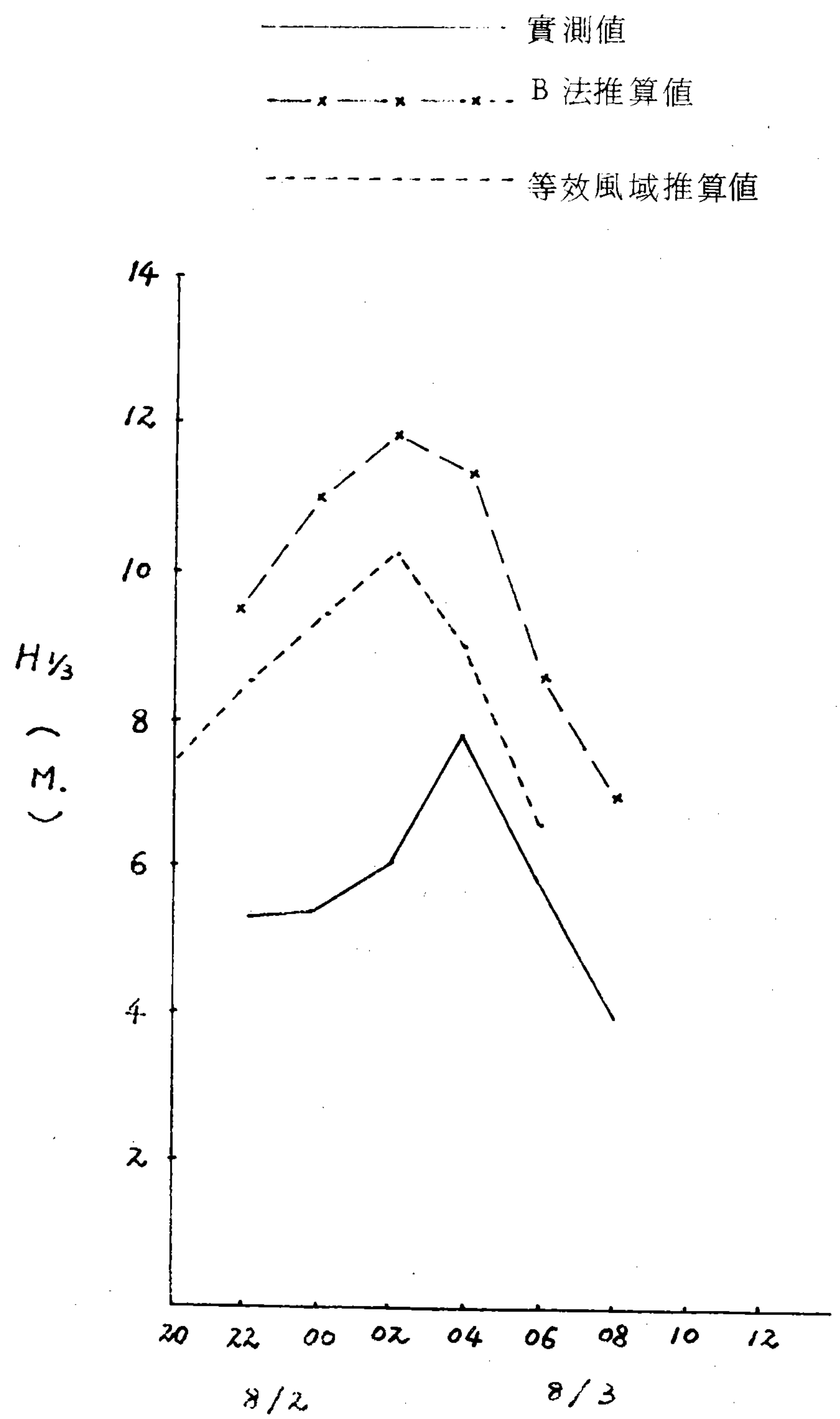


圖 5 — 9　　NINA颱風實測與推算代表波高之比較

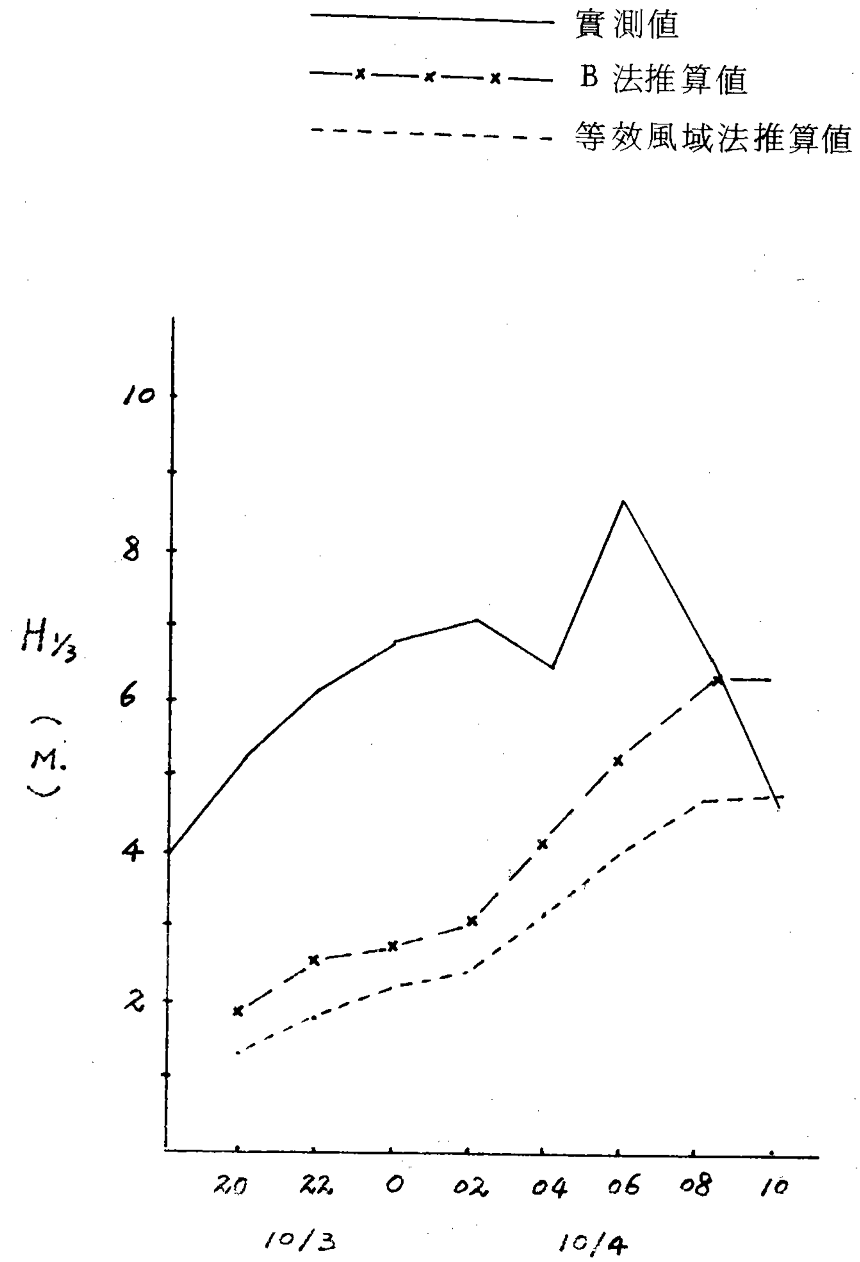


圖 5 — 10 BRENDA 颱風實測與推算代表波高之比較

5. 結論：

(1)以等效風域法推算颱風場內最大風速半徑 R 處之代表波高，與 B 法之結果相似，而數值約為 B 法所得之 85 ％。

(2)就整個風域內波浪之分佈情形而論，等效風域法在不同之 r／R 處，Hr ／ H_R 比值亦較 B 法為低，fR ／ U_R 值較小時，偏差較大，且在 r／R ＝ 2 時未有 B 法之凸起現象。

(3)與薇拉颱風之實測資料比較，等效風域法在 R 處以外的結果均相當符合，但 R 以內之情況無法推算，至於 NINA 颱風及 BRENDA 颱風則推算結果較不理想。

(4)本文僅以數個颱風之實測資料比對，在統計學上尚難論斷等效風域法之準確性，爾後應繼續配合其它實測颱風資料加以驗證。並針對颱風之特性，如強度、暴風半徑大小、路徑、行進速度等多加統計與分析，以求得更有系統的結果。

六、結論與建議

梁 乃 匡

1. 由中央氣象局所提供的風場及波浪資料所求出的風能授受系數 ξ，四個測站分別是鼻頭角 2.9E － 05，東吉島 2.4E － 05，小琉球0.96E － 05 新港 2.6E － 05 。

   由這些經驗常數所決定的模式推算出來的波浪與實測比較，波高除了新港與鼻頭角有稍偏大外，東吉島與小琉球皆很脗合，大致而言推算結果相當理想。但尚需調整風場模式，以求出最佳授受係數 ξ 。

2. 經驗常數應爲季節的函數，因此需要更多的風場資料與波浪資料來求常數群。

3. $T_{1/3}/U_{RS}$ 與 DD/T_R^2 爲最佳的推算颱風湧浪週期的參數，由目前的資料，湧浪週期推算公式爲

$$\frac{T_{1/3}}{U_{RS}} = 0.2 + 0.023\frac{DD}{T_R^2} - 0.0005\frac{(DD)^2}{T_R^4}, \quad \frac{DD}{T_R^2} \leq 20$$

$$\frac{T_{1/3}}{U_{RS}} = 0.46 \qquad \frac{DD}{T_R^2} > 20$$

4. 推測湧浪可能與當地風浪混在一起，而使 $T_{1/3}$ 變小，所以應當由波譜求出湧浪週期取代 $T_{1/3}$。

5. 由等效風域法求出的颱風波浪場與 *Bretschneider* 原來所提出者有異，何者較爲正確，應繼續以實測值來比較。

七、參考文獻

梁乃匡(1982)，颱風湧浪的預報方法
第六屆海洋工程研討會論文集

梁乃匡、簡仲璟(1983)，颱風波浪實用推算法
中國土木水利工程學會72年年會暨慶祝十週年紀念研討會論文集

Bretschneider, C.L., Tamage, E.E. (1976), Hurricane Wind and wave forecasting techniques, proceedings 15th International coastal Engineering conference, PP. 202-237.

彭海鯤(1985) 颱風受遮蔽之波浪模式探究
台灣大學海洋研究所碩士論文

附錄I　波浪預報程式


```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                  C
C        THIS PROGRAM IS FORECASTING WAVE ARROUND TAIWAN           C
C                                                                  C
C        SUPPORT BY C.W.B    SET UP BY C.C-CHIEN 1987/06/04        C
C                                                                  C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      CHARACTER*12 TYNAME(4)
      CHARACTER*2  PA
C
C                WIND DATA
      DIMENSION WS(150,800),WD(150,800),WLON(150),WLAT(150)
      DIMENSION IY(800),IM(800),ID(800),IH(800)
C
C                TYPHOON DATA
      DIMENSION ITY(4,120),ITM(4,120),ITD(4,120),ITH(4,120)
      DIMENSION TLAT(4,120),TLON(4,120),PD(4,120),VF(4,120),R(4,120)
C
C                MONSOON WAVE
      DIMENSION HM(100,80),PM(100,80)
C
C                TYPHOON WAVE
      DIMENSION HT(4,120,100),PT(4,120,100)
      DIMENSION KTY(4,120,100),KTH(4,120,100)
      DIMENSION KKTH(4,120,100),TLAG(4,120,100)
C
C                WAVE GRID POSITION & CONSTANTS
      DIMENSION GLON(100),GLAT(100),CURSI(100),CD(100,4)
C
C                OTHERS
      DIMENSION FAC(5),LL(4)
C
C                LAND DATA
      DIMENSION XL(500),YL(500),XX(200),YU(200),YD(200)
      DIMENSION YY(200),XU(200),XD(200)
C
C                OUTPUT DATA
      DIMENSION H(100),T(100),WAVDIR(100)
C
C     TOTAL DIMENSION = 646069
C
C
C     OPEN INPUT DATA FILE
C
      OPEN(UNIT=10,FILE='MONSOON.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=21,FILE='TYPH1.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=22,FILE='TYPH2.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=23,FILE='TYPH3.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=24,FILE='TYPH4.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=30,FILE='GRID.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=41,FILE='LAND.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=42,FILE='XLAND.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=43,FILE='YLAND.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=50,FILE='NOBEL.DAT',FORM='FORMATTED',STATUS='OLD')
      OPEN(UNIT=70,FILE='TEST.DAT',FORM='FORMATTED',STATUS='NEW')
C
C     READ IN WIND DATA , L IS DATA BLOCK NO.
C                 WIND FIELD GRID NO. I=150
```


港灣技術研究所

```
C                         WS = WIND SPEED
C                         WD = WIND DIRECTION
C
      L=1
50    READ(10,11,END=19)IY(L),IM(L),ID(L),IH(L)
11    FORMAT(4(1X,I2))
      DO 90 I=1,150
90    READ(10,12,END=19)WS(I,L),WD(I,L)
12    FORMAT(2(4X,F6.2))
      L=L+1
      GO TO 50
C
C     READ IN TYPHOON DATA
C                         LL(I) IS DATA BLOCK NO. OF
C                         TYPHOON(I), I=1,2,3,4
C
19    L=L-1
      LL1=1
      WRITE(5,8001)L
8001  FORMAT(5X,'8001',2X,'L=',I5)
      READ(21,13,END=29)TYNAME(1)
13    FORMAT(A12)
61    READ(21,11,END=29)ITY(1,LL1),ITM(1,LL1),ITD(1,LL1),ITH(1,LL1)
      READ(21,25,END=29)TLAT(1,LL1),TLON(1,LL1),PD(1,LL1),VF(1,LL1)
     -,R(1,LL1)
25    FORMAT(2(1X,F7.2),3(1X,F7.1))
      LL1=LL1+1
      GO TO 61
29    LL2=1
      READ(22,13,END=39)TYNAME(2)
62    READ(22,11,END=39)ITY(2,LL2),ITM(2,LL2),ITD(2,LL2),ITH(2,LL2)
      READ(22,25,END=39)TLAT(2,LL2),TLON(2,LL2),PD(2,LL2),VF(2,LL2)
     -,R(2,LL2)
      LL2=LL2+1
      GO TO 62
39    LL3=1
      READ(23,13,END=49)TYNAME(3)
63    READ(23,11,END=49)ITY(3,LL3),ITM(3,LL3),ITD(3,LL3),ITH(3,LL3)
      READ(23,25,END=49)TLAT(3,LL3),TLON(3,LL3),PD(3,LL3),VF(3,LL3)
     -,R(3,LL3)
      LL3=LL3+1
      GO TO 63
49    LL4=1
      READ(24,13,END=59)TYNAME(4)
64    READ(24,11,END=59)ITY(4,LL4),ITM(4,LL4),ITD(4,LL4),ITH(4,LL4)
      READ(24,25,END=59)TLAT(4,LL4),TLON(4,LL4),PD(4,LL4),VF(4,LL4)
     -,R(4,LL4)
      LL4=LL4+1
      GO TO 64
C
C      READ IN WIND AND WAVE GRID POSITION & CONSTANT DATA
C                             WIND GRID NO. I=150
C                                     COORDINATE  X=WLON(I) Y=WLAT(I)
C                             WAVE GRID NO. K=89
C                                     COORDINATE  X=GLON(K) Y=GLAT(K)
C                             CURSI(K),CO(K,J) J=1,2,3,4 ARE CONSTANTS
C
59    DO 103 I=1,150
```

I—2

```
      READ(30,113)WLON(I),WLAT(I)
103   WRITE(5,113)WLON(I),WLAT(I)
113   FORMAT(10X,F7.3,5X,F7.3)
      DO 104 K=1,89
      READ(30,114)GLON(K),GLAT(K),CURSI(K),CO(K,1),CO(K,2),CO(K,3),
     -CO(K,4)
104   WRITE(5,114)GLON(K),GLAT(K),CURSI(K),CO(K,1),CO(K,2),CO(K,3),
     -CO(K,4)
114   FORMAT(10X,F7.3,5X,F7.3,5(2X,E8.2))
C      WRITE(5,8020)J,I,WLON(1),WLAT(1),GLON(1),GLAT(1)
C
C     READ IN LAND,XLAND,YLAND.DAT
C                                   LAND DATA NO. = IA
C                                  XLAND DATA NO. = IB
C                                  YLAND DATA NO. = IC
C
      IA=1
3012    READ(41,3011,END=3050)XL(IA),YL(IA),ICODE
3011    FORMAT(1X,F6.2,2X,F6.2,2X,I2)
      IF(ICODE.EQ.99) GO TO 3050
      IA=IA+1
      GO TO 3012
C
C      READ XLAND DATA
C
3050    IB=1
3022    READ(42,3021,END=3060)XX(IB),YU(IB),YD(IB),ICODE
3021    FORMAT(1X,F6.2,2X,F6.2,2X,F6.2,2X,I2)
      IF(ICODE.EQ.99) GO TO 3060
      IB=IB+1
      GO TO 3022
C
C      READ YLAND DATA
C
3060    IC=1
3032    READ(43,3021,END=3070)YY(IC),XU(IC),XD(IC),ICODE
      IF(ICODE.EQ.99) GO TO 3070
      IC=IC+1
      GO TO 3032
C
C     CHECK THE WIND DATA LENGTH (=L)
C
3070  IF(L.LT.40) GO TO 333
C
C     ENTER THE CURRENT TIME INCLUDE (YEAR,MONTH,DAY,HOUR)
C
      WRITE(5,1)
9
1     FORMAT(//5X,'ENTER THE CURRENT TIME ,YEAR,MONTH,DAY,HOUR 4I2 ',$)
      READ(5,2)IYC,IMC,IDC,IHC
2     FORMAT(4I2)
      WRITE(5,3)IYC,IMC,IDC,IHC
3     FORMAT(/5X,'YEAR=',I2,3X,'MONTH=',I2,3X,'DAY=',I2,3X,'HOUR=',I2)
      WRITE(5,4)
4     FORMAT(/5X,'CURRENT TIME IS CORRECT ? (YE.OR.NO)',$)
      READ(5,5)PA
5     FORMAT(A2)
      IF(PA.EQ.'YE') GO TO 70
      GO TO 9
```

I—3

港灣技術研究所

```
C
C      TRANSFER (CURRENT TIME) TO (CURRENT ABSOLUTE TIME) [IABSYC,IABSHC]
C
70     CALL TRTIME(IYC,IMC,IDC,IHC,IABSYC,IABSHC,1)
C
C      CHECK THE CURRENT ABSOLUTE TIME INNER ABS. TIME OF WIND DATA
C             YE --> GO TO 85
C                  KK & KL : UP ONE STEP WIND DATA SERIES NO. (TOTAL NO.=L)
C                       TI : TIME DIFFERENCE OF CURRENT ABS. TIME AND
C                            UP ONE STEP WIND DATA ABS. TIME
C                        M : WIND DATA SERIES NO. OF UP FORTY STEP
C             NO --> GO TO 334
C
       DO 80 I=1,L
       IYI=IY(I)
       IMI=IM(I)
       IDI=ID(I)
       IHI=IH(I)
C
C      TRANSFER WIND DATA TIME TO ABS. TIME
C
       CALL TRTIME(IYI,IMI,IDI,IHI,IABSYI,IABSHI,1)
       IF(IABSYC.GT.IABSYI) GO TO 84
       IF(IABSHC.GT.IABSHI) GO TO 84
       KK=I-1
       KL=KK
       WRITE(5,8002)KK
8002   FORMAT(5X,'8002',2X,'KK=',I5)
       IF((L-KK).GE.85) GO TO 336
       GO TO 85
84     IF(I.EQ.L) GO TO 334
80     CONTINUE
85     TI=3-(IABSHI-IABSHC)
C
C      MONSOON WAVE DATA CALCULATING...
C                        FOR 89 POINTS
C
       NON=1
171    M=KK-40
       IF(M.LT.0) GO TO 337
       DO 150 J=1,89
C
C      REST INITIAL VALUE
C
       M=KK-40
       SUUBA=0.
       DUR=0.
       SUUBB=0.
       SMUDR=0.
       SMDR=0.
       SUMSK=0.
       DELT=0.
       F=0.
       COUNT=0.
       DT=3.0
C
C      ACCUMULATING FORTY STEPS FOR UPPER CONSTANTS ACCORDING TO WIND DATA
C                     [ 5*8=40 DATA TIME INTERVAL = 3 HOURS
```


港灣技術研究所

```
C                   , SO WE HAVE 8 DATUM IN ONE DAY     ]
C
      DO 152 N=1,40
      M=M+1
      IYM=IY(M)
      IMM=IM(M)
      IDM=ID(M)
      IHM=IH(M)
C
C     TRANSFER WIND DATA TIME TO ABS. TIME
C
      CALL TRTIME(IYM,IMM,IDM,IHM,IABSYM,IABSHM,1)
      LL(1)=LL1
      LL(2)=LL2
      LL(3)=LL3
      LL(4)=LL4
C
C     CHECK IN THIS WIND DATA STEP THE ABS. TIME SUPERPOSITION
C           TYPHOON CATA ABS. TIME
C                YE --> IF THESE POINTS INNER 10R (GO TO SUBROUTINE SUBT)
C                                                 CHANGE THE WS(I,L)=0.
C                NO --> NO CHANGE
C
      DO 107 IPI=1,4
      KE=LL(IPI)
      DO 105 KPK=1,KE
      ITYI=ITY(IPI,KPK)
      ITMI=ITM(IPI,KPK)
      ITDI=ITD(IPI,KPK)
      ITHI=ITH(IPI,KPK)
C
C     TRANSFER TYPHOON DATA TO ABS. TIME IN THIS STEP
C
      CALL TRTIME(ITYI,ITMI,ITDI,ITHI,IABSYI,IABSHI,1)
      IF(IABSHM.EQ.IABSHI) GO TO 115
105   CONTINUE
115   CALL SUBT(IPI,KPK,M,TLAT,TLON,PO,VF,R,WS,WLON,WLAT)
107   CONTINUE
C
C     CONSIDER 150 POINTS OF WIND FILED
C
      DO 154 I=1,150
      XM=WLON(I)
      YM=WLAT(I)
      XA=GLON(J)
      YA=GLAT(J)
C      WRITE(5,8020)J,I,XM,YM,XA,YA
C8020  FORMAT(5X,'J=',I4,' I=',I4,' XM=',F7.3,' YM=',F7.3,' XA=',F7.3,
C     -' YA=',F7.3)
      CALL DIS(XA,YA,XM,YM,RR)
      CALL ANG(XM,YM,XA,YA,CO,IEEP)
      DA=2*3.14159*6366.71**2.*ABS(COSD(90.5-YA)-COSD(89.5-YA))/360.
      IF(F.LE.RR) F=RR
      IF(IEER.EQ.1) GO TO 154
      RLU=0.5*WS(I,M)*(TI+(41-N)*DT)*3.6
      RLL=0.5*WS(I,M)*(TI+(40-N)*DT)*3.6
      BETA=ABS(CO-WD(I,M))
      IF(BETA.GT.180.) BETA=360.-BETA
```

```
      IF(BETA.GE.90.) GO TO 154
C
C     CONSIDER SHELTERING EFFECT JEER = 1 SHELTERING OCCURED
C                                JEER = 0 SHELTERING NO HAPPENED
C
      CALL SHELT(XM,YM,XA,YA,XX,YU,YC,YY,XU,XD,XL,YL,JEER
     -,IA,IB,IC)
      IF(ABS(JEER-1).LE.0.005) GO TO 154
      COUNT=COUNT+1
C      WRITE(5,8005)RL,RR
C8005  FORMAT(5X,'RL=',F8.2,'  RR=',F8.2)
      CALL EAREA(RR,RLU,RLL,DA,CD)
      IF(DA.LT.0.0005) GO TO 154
C      WRITE(5,8008)
C8008  FORMAT(5X,'STEP 4')
      SUUBA=WS(I,M)*WS(I,M)*COSD(BETA)*EXP(-0.08*RR/(WS(I,M)
     -*WS(I,M)))*DA/RR
      SMUDR=SMUDR+WS(I,M)
      SMDR=SMDR+1
      SUMSK=SUMSK+SUUBA*WD(I,M)
      SUUBB=SUUBB+SUUBA
      DELT=TI+(40-N)*DT
      IF(DUR.LE.DELT) DUR=DELT
154   CONTINUE
152   CONTINUE
      IF(SUUBB.EQ.0.) GO TO 335
      IF(SMDR.LE.0.) GO TO 335
      AA=2.*3.14159/9.8
      WAVDIR(J)=SUMSK/SUUBB
      TDUR=TI+DUR
      UMEAN=SMUDR/SMDR
      TSF=AA*UMEAN*((9800.*F/UMEAN**2.)*CO(J,1)+CO(J,2))
      TSD=AA*UMEAN*((35280.*TDUR/UMEAN)*CO(J,3)+CO(J,4))
      HSF=SQRT(CURSI(J)*0.82*SUUBB/TSF)
      HSD=SQRT(CURSI(J)*0.82*SUUBB/TSD)
      GO TO 159
335   TSF=0.0
      TSD=0.0
      HSF=0.0
      HSD=0.0
C
C     OUTPUT RESULT IYO,IMO,IDO,IHO
C
C                          J,XA,YA,HSD,TSD,HSF,TSF,WAVDIR(J),COUNT
159   HM(J,NON)=HSF
      PM(J,NON)=TSF
      WRITE(5,8030)HSF,TSF,HSD,TSD,UMEAN
8030  FORMAT(5X,'HSF=',F7.2,' TSF=',F7.2,' HSD=',F7.2,' TSD=',F7.2,
     -' UM=',E8.2)
C      WAVDIR(J,IABSYC,IABSHC)=WAVDIR(J)
150   CONTINUE
      KK=KK+1
      IABSHC=IABSHC+3
      NON=NON+1
      WRITE(5,8003)KK,NON,L
8003  FORMAT(5X,'8003',' KK=',I5,' NON=',I5,' L=',I5)
      IF(KK.GE.L) GO TO 2000
      GO TO 171
```

```
      IF(KK.GE.L) GO TO 2000
      GO TO 171
```


_DJA1:[CHIEN.CWB]WAVET2.FOR;6

```
2000  CALL TYPHOON(LL,TLAT,TLON,PD,VF,R,ITY,ITM,ITD,ITH,KTY,KTH,HT,PT,
     -KKTH,TLAG,XX,YU,YD,YY,XU,XD,XL,YL,IA,IB,IC,GLON,GLAT)
      DO 8200 N=1,3
      DO 8250 I=1,8
      DO 8300 J=1,89
      WRITE(70,71)N,I,J,HT(N,I,J),PT(N,I,J)
71    FORMAT(5X,'N= ',I4,' I= ',I4,' J= ',I4,' HT= ',F7.2,' PT = ',F7.2)
8300  CONTINUE
8250  CONTINUE
8200  CONTINUE
      CALL MPTWV(LL,KTY,KKTH,HT,TLAG)
C
C     RESET WAVE HEIGHT & PERIOD DISTRIBUTE
C
      CALL TRTIME(IYC,IMC,IDC,IHC,IABSYC,IABSHC,1)
      ICY=IABSYC
      ICH=IABSHC
      FAC(1)=0.33333
      FAC(2)=0.66667
      FAC(3)=1.
      FAC(4)=0.66667
      FAC(5)=0.33333
      NO=1
1234  DO 100 J=1,89
      SUMH=HM(J,NO)
      SUMT=PM(J,NO)
      K=1
C
C     FOR MONSOON WAVE
C
C      DO 200 LP=NO-2,NO+2
C      IF(LP.LE.0) GO TO 202
C      IF(LP.GT.NON) GO TO 202
C      THM=(HM(J,LP)**2.)*FAC(K)
C      SUMH=SUMH+THM
C      SUMT=SUMT+THM*PM(J,LP)
C202   K=K+1
C200   CONTINUE
C
C     FOR TYPHOON WAVE
C
      ICOUNT=0
      DO 300 N=1,4
      KE=LL(N)
      DO 400 I=2,KE
      IF(KTY(N,I,J).NE.ICY) GO TO 300
      IDH=ABS(ICH-KTH(N,I,J))
      IF(IDH.GE.3) GO TO 400
      ICOUNT=ICOUNT+1
      KK=3-IDH
      THT=(HT(N,I,J)**2.)*FAC(KK)
      SUMH=SUMH+THT
      SUMT=SUMT+THT*PT(N,I,J)
400   CONTINUE
300   CONTINUE
      IF(ICOUNT.EQ.0) GO TO 301
      H(J)=SQRT(SUMH)
```

```
                        T(J)=0.
                    ELSE
                        T(J)=SUMT/SUMH
      END IF
      GO TO 100
301   H(J)=SUMH
      T(J)=SUMT
100   CONTINUE
      CALL TRTIME(IYC,IMC,IDC,IHD,ICY,ICH,-1)
      WRITE(50,5001)IYO,IMO,IDO,IHO
5001  FORMAT(//5X,'YEAR=',I3,3X,'MONTH=',I3,3X,'DAY=',I3,3X,'HOUR='
     -,I3,3X)
      DO 5005 I=1,89
5005  WRITE(50,5002)I,H(I),T(I)
5002  FORMAT(/5X,'POINT NO =',I3,3X,'H13=',F7.2,3X,'T13=',F7.2)
      KL=KL+1
      ICH=ICH+3
      IF(KL.GE.L) GO TO 9999
      NO=NO+1
      GO TO 1234
333   WRITE(5,3331)
      GO TO 9999
3331  FORMAT(5X,'ERROR')
334   WRITE(5,3331)
      GO TO 9999
336   WRITE(5,3331)
      GO TO 9999
337   WRITE(5,3331)
      GO TO 9999
9999  CLOSE(UNIT=10)
      CLOSE(UNIT=21)
      CLOSE(UNIT=22)
      CLOSE(UNIT=23)
      CLOSE(UNIT=24)
      CLOSE(UNIT=30)
      CLOSE(UNIT=41)
      CLOSE(UNIT=42)
      CLOSE(UNIT=43)
      CLOSE(UNIT=50)
      CLOSE(UNIT=70)
      STOP
      END
      SUBROUTINE  TYPHOON(LL,TLAT,TLON,PO,VF,RPR,ITY,ITM,ITD,ITH,KTY,
     -KTH,HT,PT,KKTH,TLAG,XX,YU,YD,YY,XU,XD,XL,YL,IA,IB,IC,GLON,GLAT)
      CHARACTER*5 NAME
      DIMENSION LL(4),TLAT(4,120),TLON(4,120),PO(4,120),VF(4,120)
      DIMENSION RPR(4,120),ITY(4,120),ITM(4,120),ITD(4,120),ITH(4,120)
      DIMENSION GLON(100),GLAT(100)
      DIMENSION KTY(4,120,100),KTH(4,120,100),HT(4,120,100)
      DIMENSION PT(4,120,100),KKTH(4,120,100),TLAG(4,120,100)
      DIMENSION XL(500),YL(500),XX(200),YU(200),YD(200)
      DIMENSION YY(200),XU(200),XD(200)
      DO 100 N=1,4
      L=LL(N)
      DO 200 I=1,L
      X1=TLON(N,I)
      Y1=TLAT(N,I)
      IF((I+1).GE.L) GO TO 100
```

```
      X2=TLON(N,I+1)
      Y2=TLAT(N,I+1)
      DO 300 J=1,89
      XM=GLON(J)
      YM=GLAT(J)
      CALL SHELT(X1,Y1,XM,YM,XX,YU,YD,YY,XU,XD,XL,YL,JEER,IA,IB,IC)
      IF(ABS(JEER-1).LE.0.005) GO TO 300
      CALL DIS(X1,Y1,XM,YM,AM)
      CALL DIS(X1,Y1,X2,Y2,AB)
      CALL ANGULE(X2,Y2,X1,Y1,ALPHA,IERR)
      CALL ANGULE(X1,Y1,XM,YM,THETA,IERR)
      BETA=ABS(ALPHA-THETA+65)
      IF(BETA.GE.180.) THEN
                        GAMA=360.-BETA
                  ELSE
                        GAMA=BETA
      END IF
      IF(VF(N,I).LT.0.) THEN
                     VVF=AB/(3.*1.852)
                     GO TO 116
                  ELSE
                     VVF=VF(N,I)
      END IF
116   PPO=PO(N,I)
      IF(PPO.GE.1000.) GO TO 200
      IF(VVF.GE.30.) VVF=30.
      DELU=0.5*VVF*COSD(GAMA)
      P=ABS(YM-Y1)
      A=90.-X1
      B=90.-XM
      DD=60.*ACOSD(1.-((1.-COSD(P))*SIND(A)*SIND(B)+(1-COSD(A-B))))
C      DD=AM/1.852
      DELP=(1000.+(1000.-PPO)/10.-PPO)/33.86
      RPL=(28.52*TANH(0.0873*(Y1-28.))+12.22*EXP((PPO-1013.2)/33.86)
     -+0.2*VVF*1.852+37.22)/1.852
      RK=70.-Y1/7.5
C      UR=(RK*SQRT(DELP)-0.2632*SIND(Y1)*RPL-5.965*SIND(Y1))/(1+
C     -0.04386*SIND(Y1))
      UR=RK*SQRT(DELP)-0.5*0.5263*RPL
      IF(UR.LE.0.) UR=0.01
      R=RPL*EXP((PPO-1013.2)/(33.86*2.3))
C      IF(UR.LT.100.) GO TO 51
C      R=RPL-((UR-100.)/6.+6.)
C      GO TO 50
C51    R=RPL
      FRUR1=0.5263*SIND(Y1)*R/UR
      FRUR2=0.5263*SIND(Y1)*RPL/UR
      IF(DD.EQ.0.) DD=0.0001
      SUR=UR*(((0.5*FRUR1*DD/R)**2.+(1+FRUR1)*(R/DD)*EXP(1-R/DD))
     -**0.5-0.5*FRUR1*DD/R)
      IF(SUR.LE.0.)SUR=0.1
      URA=0.865*UR
      SURA=0.865*SUR
      URAA=URA+DELU
      SURAA=SURA+DELU
      PK1=7.59-41.21*FRUR1+160.51*FRUR1**2.-219.32*FRUR1**3.
      PK2=7.59-41.21*FRUR2+160.51*FRUR2**2.-219.32*FRUR2**3.
      IF(PK1.LE.0.) PK1=0.2
```

```
      IF(PK1.GE.7.59) PK1=7.59
      IF(PK2.LE.0.) PK2=0.2
      IF(PK2.GE.7.59) PK2=7.59
      HR=PK2*SQRT(RPL*DELP)
      HRS=PK2*SQRT(R*DELP)
      RR=DD/R
      IF(RR.LE.10.) GO TO 1000
      H13=0.11*HR*RPL/DD**0.5
      IF(URAA.LE.0.) GO TO 113
      HRA=HR*(1+DELU/URAA)**2.
      CALL PERIOD(HRA,URAA,TA,IERR)
      IF(IERR.EQ.1) GO TO 113
      DTRU=(DD*TA)/(RPL*URAA)
      IF(URAA.LE.0.) DTRU=0.2
      CP=0.0021*DTRU**2.+0.0012*DTRU+1.21
      T13=CP*TA
      GO TO 114
113   T13=10.0
114   NAME='SWELL'
      IF(T13.EQ.0.) GO TO 900
      TLAG(N,I,J)=DD/(3.6*0.78*T13)
      GO TO 9900
1000  CALL BRET(FRUR1,RR,RH,IERR)
      IF(IERR.EQ.1) GO TO 200
      IF(RH.GE.1.22) RH=1.2
      SHR=HRS*RH
      IF(SURAA.LE.0.) SHR=0.
      IF(SURAA.LT.ABS(DELU)) SURAA=4.*ABS(DELU)
      SHRA=SHR*(1+DELU/SURAA)**2.
      CALL PERIOD(SHRA,SURA,STA,IERR)
      IF(IERR.EQ.1) THEN
                    STA=4.0
                    IF(SURA.LE.21.5) SURA=22.
                    QC=8.46/(0.4*SURA)
                    CW=QC+QC**3./3.+QC**5./5.+QC**7./7.
                    QA=2.*CW**1.67
                    AW=(EXP(QA)-1.)/(EXP(QA)+1.)
                    SHRA=(AW*SURA*SURA)/40.
                 ELSE
                    SHRA=SHRA

       END IF
       H13=SHRA/3.28
       T13=4.*SQRT(STA)
       NAME=' WIND'
       TLAG(N,I,J)=0.0
9900   ITYI=ITY(N,I)
       ITMI=ITM(N,I)
       ITDI=ITD(N,I)
       ITHI=ITH(N,I)
       CALL TRTIME(ITYI,ITMI,ITDI,ITHI,IABSTY,IABSTH,1)
       KKTH(N,I,J)=IABSTH
       KTY(N,I,J)=IABSTY
       KTH(N,I,J)=IABSTH+TLAG(N,I,J)
       HT(N,I,J)=H13
       PT(N,I,J)=T13
       GO TO 300
900    KTY(N,I,J)=IABSTY
```

```
        KTH(N,I,J)=IABSTH
        HT(N,I,J)=0.
        PT(N,I,J)=0.
300     CONTINUE
200     CONTINUE
100     CONTINUE
        RETURN
        END
        SUBROUTINE PERIOD(X,Y,Z,IERR)
C        COMMON X,Y,Z,IERR
        A=(40.*X)/Y**2.
        IF(A.GE.1.) GO TO 10
        B=ALOG((1+A)/(1-A))
        C=(0.5*B)**0.6
        D=0.4*TANH(C)*Y
        Z=(4./5.)**0.25*D
        IERR=0
        GO TO 1
10      IERR=1
1       RETURN
        END
        SUBROUTINE BRET(FRUR,RR,RATE,IERR)
        DIMENSION A(10),C(10,10),V(10)
        CHARACTER*2 PA
        IERR=0
        A(1)=0.
        A(2)=0.02
        A(3)=0.04
        A(4)=0.06
        A(5)=0.10
        A(6)=0.16
        A(7)=0.20
        A(8)=0.30
        A(9)=0.50
        C(1,1)=0.10017835E-5
        C(1,2)=-0.61861162E-4
        C(1,3)=0.14723198E-2
        C(1,4)=-0.1790538E-1
        C(1,5)=0.12099124
        C(1,6)=-0.45196415
        C(1,7)=0.7997339
        C(1,8)=0.54218079
        C(2,1)=-0.85238E-6
        C(2,2)=0.17119E-4
        C(2,3)=0.9522E-4
        C(2,4)=-0.521E-2
        C(2,5)=0.54727E-1
        C(2,6)=-0.259325
        C(2,7)=0.5031576
        C(2,8)=0.705566
        C(3,1)=0.0
        C(3,2)=-0.81968951E-5
        C(3,3)=0.3733249E-3
        C(3,4)=-0.65767033E-2
        C(3,5)=0.575878E-1
        C(3,6)=-0.26153058
        C(3,7)=0.48609795
        C(3,8)=0.72522351
```

```
      C(4,1)=-0.610529E-5
      C(4,2)=0.22E-3
      C(4,3)=-0.30722E-2
      C(4,4)=0.20411E-1
      C(4,5)=-0.59381E-1
      C(4,6)=0.173E-1
      C(4,7)=0.12855E23
      C(4,8)=0.89655646
      C(5,1)=0.0
      C(5,2)=-0.145E-4
      C(5,3)=0.567342E-3
      C(5,4)=-0.8899732E-2
      C(5,5)=0.713E-1
      C(5,6)=-0.29734355
      C(5,7)=0.45821415
      C(5,8)=0.77636381
      C(6,1)=-0.13371897E-4
      C(6,2)=0.52797074E-3
      C(6,3)=-0.8410413E-2
      C(6,4)=0.68857376E-1
      C(6,5)=-0.30413751
      C(6,6)=0.69923971
      C(6,7)=-0.8973324
      C(6,9)=1.4709649
      C(7,1)=0.0
      C(7,2)=-0.13745E-4
      C(7,3)=0.5212115E-3
      C(7,4)=-.7394E-2
      C(7,5)=0.6265148E-1
      C(7,6)=-0.246365
      C(7,7)=0.2671735
      C(7,8)=0.92671
      C(8,1)=0.0
      C(8,2)=-0.23091255E-4
      C(8,3)=0.92845633E-3
      C(8,4)=-0.14887704E-1
      C(8,5)=0.11905687
      C(8,6)=-0.46714977
      C(8,7)=0.60754091
      C(8,8)=0.74695602
      C(9,1)=0.74204823E-5
      C(9,2)=-0.31812369E-3
      C(9,3)=0.56309258E-2
      C(9,4)=-0.52851118E-1
      C(9,5)=0.27785340
      C(9,6)=-0.76195305
      C(9,7)=0.68421671
      C(9,8)=0.84775850
      IF(RR.LT.1) GO TO 1000
      RE=RR
      FA=FRUR
      DO 100 I=1,9
100   V(I)=C(I,1)*RE**7+C(I,2)*RE**6+C(I,3)*RE**5+C(I,4)*RE**4
     -+C(I,5)*RE**3+C(I,6)*RE**2+C(I,7)*RE+C(I,8)
      DO 200 I=1,9
      IF((FA-A(I)).GT.0.) GO TO 200
      K=I
      GO TO 400
```

```
200   CONTINUE
      HR=V(9)
      GO TO 500
400   IF(K.EQ.1)GO TO 600
      HR=((FA-A(K-1))/(A(K)-A(K-1)))*(V(K)-V(K-1))+V(K-1)
      GO TO 500
600   HR=V(1)
500   RATE=HR
      GO TO 900
1000  RATE=1.
900   RETURN
      END
      SUBROUTINE ANGULE(X1,Y1,X2,Y2,ANG,IERR)
      IERR=0
      AY=Y1-Y2
      AX=X1-X2
      IF(AX.EQ.0.) GO TO 20
      ANG=ATAND(AY/AX)
      IF(AX.GT.0.) THEN
                 ANG=ANG
              ELSE
                 ANG=ANG+180.
      END IF
      GO TO 200
20    IF(AY.EQ.0.) GO TO 50
      IF(AY.GT.0.) THEN
                ANG=90.
              ELSE
                ANG=270.
      END IF
      GO TO 200
50    ANG=0.
      IERR=1
200   RETURN
      END
      SUBROUTINE SUBT(I,K,M,TLAT,TLON,PO,VF,R,WS,WLON,WLAT)
      DIMENSION TLAT(4,160),TLON(4,160),PO(4,160),VF(4,160),R(4,160)
      DIMENSION WS(150,1200),WLON(150),WLAT(150)
      IF(R(I,K).GT.0.) GO TO 5
      RPL=(28.52*TANH(0.0873*(TLAT(I,K)-28.))+12.22*EXP((PO(I,K)-1013.2)
     -/33.86)+0.2*VF(I,J)*1.852+37.22)/1.852
      GO TO 10
5     RPL=R(I,K)
10    XA=TLON(I,K)
      YA=TLAT(I,K)
      DO 100 J=1,150
      XM=WLON(J)
      YM=WLAT(J)
      CALL DIS(XA,YA,XM,YM,RD)
      IF(RD.GE.(RPL*9.5)) GO TO 100
      WS(J,M)=0.
100   CONTINUE
      RETURN
      END
      SUBROUTINE SHELT(XI,YI,XM,YM,XX,YU,YD,YY,XU,XD,XL,YL,JEER,
     -I,II,III)
      DIMENSION XL(500),YL(500),XX(200),YU(200),YD(200)
      DIMENSION YY(200),XU(200),XD(200)
```

```
      DIMENSION XL(500),YL(500),XX(200),YU(200),YD(200)
      DIMENSION YY(200),XU(200),XD(200)
```



```
      JEER=0
C     DO 70 K=1,10
C70   WRITE(5,7010)XX(K),YU(K),YD(K),YY(K),XU(K),XD(K),XL(K),YL(K)
C7010 FORMAT(1X,8(F7.2,1X))
      XMI=XM-XI
      YMI=YM-YI
      IF(ABS(XMI).LT.0.01) GO TO 750
      IF(ABS(YMI).LT.0.01) GO TO 700
      DO 670 K=1,II
      Y=YMI*XX(K)/XMI+(YI*XM-YM*XI)/XMI
      YIO=(Y-YU(K))*(Y-YD(K))
      YIOI=(Y-YI)*(Y-YM)
      IF(YIO.LE.0.AND.YIOI.LE.0) GO TO 201
670   CONTINUE
      DO 680 K=1,III
      X=XMI*YY(K)/YMI+(YM*XI-YI*XM)/YMI
      XIO=(X-XU(K))*(X-XD(K))
      XIOI=(X-XI)*(X-XM)
      IF(XIO.LE.0.AND.XIOI.LE.0) GO TO 201
680   CONTINUE
      GO TO 800
700   DO 705 K=1,II
      YIO=(YM-YU(K))*(YM-YD(K))
      XIO=(XX(K)-XM)*(XX(K)-XI)
      IF(YIO.LE.0.AND.XIO.LE.0) GO TO 201
705   CONTINUE
      GO TO 800
750   DO 755 K=1,III
      XIO=(XM-XU(K))*(XM-XD(K))
      YIO=(YY(K)-YM)*(YY(K)-YI)
      IF(XIO.LE.0.AND.YIO.LE.0) GO TO 201
755   CONTINUE
      GO TO 800
201   JEER=1
800   RETURN
      END
      SUBROUTINE TRTIME(IY,IM,ID,IH,IABSY,IABSH,ICODE)
      DIMENSION MM(12)
C
C      ICODE.GT.0 IS TRANSFER NORMAL TIME TO ABSOLUTE TIME
C      ICODE.LT.0 IS TRANSFER ABSOLUTE TIME TO NORMAL TIME
C
      IF(ICODE.GT.0) GO TO 10
      RY=1911+IABSY
      GO TO 15
10    RY=1911+IY
15    FY=RY/4.
      KY=RY/4.
      IF((FY-KY).GT.0.001) GO TO 50
      MM(1)=0
      MM(2)=31
      MM(3)=60
      MM(4)=91
      MM(5)=121
      MM(6)=152
      MM(7)=182
```

```
      MM(10)=274
      MM(11)=305
      MM(12)=335
      IF(ICODE.GT.0) GO TO 60
      GO TO 20
50    MM(1)=0
      MM(2)=31
      MM(3)=59
      MM(4)=90
      MM(5)=120
      MM(6)=151
      MM(7)=181
      MM(8)=212
      MM(9)=243
      MM(10)=273
      MM(11)=304
      MM(12)=334
      IF(ICODE.GT.0) GO TO 60
      GO TO 20
60    IABSY=IY
      IABSH=MM(IM)*24+(ID-1)*24+IH
      GO TO 100
20    MMM=(MM(12)+31)*24
      IF(IABSH.GT.MMM) GO TO 40
      GO TO 25
40    IABSH=IABSH-MMM
C      WRITE(5,70)IABSH,MMM
C70    FORMAT(5X,'IABSH=',I5,'    MMM=',I5)
      IY=IABSY+1
      IM=1
      IK=IABSH/24
      IJ=IK*24
      IH=IABSH-IJ
      ID=IK+1
      GO TO 100
25    IK=IABSH/24
      IJ=IK*24
      IH=IABSH-IJ
      DO 30 I=1,12
      IF(IK.GE.MM(I)) GO TO 35
      IM=I-1
      GO TO 45
35    IF(I.EQ.12) IM=12
30    CONTINUE
45    ID=IK-MM(IM)+1
      IY=IABSY
100   RETURN
      END
      SUBROUTINE ANG(XA,YA,XM,YM,CO,IEER)
      DY=YA-YM
      DX=XA-XM
      IEER=0
      IF(DX.EQ.0.AND.DY.EQ.0.) GO TO 9999
      IF(DX.EQ.0.AND.DY.GT.0.) GO TO 505
      IF(DX.EQ.0.AND.DY.LT.0.) GO TO 510
      GO TO 550
505   CO=0.
      GO TO 600
```

```
510   CD=180.
      GO TO 600
550   CD=ATAND(DY/DX)
      IF(DX.GT.0.AND.DY.GT.0.) GO TO 525
      IF(DX.LT.0.) GO TO 530
      IF(DX.GT.0.AND.DY.LT.0.) GO TO 525
      GO TO 600
525   CD=90-CD
      GO TO 600
530   CD=270.-CD
      GO TO 600
9999  IEER=1
600   RETURN
      END
      SUBROUTINE MPTWV(LK,KTY,KKTH,HT,TLAG)
C
C      THIS PROGRAM IS MODIFY THE WAVE HEIGHT AND PERIOD.
C      IT'S CONSIDER THE SUPERPOSITION , OVERLAPPED , . . . ETC
C      WHEN TIME LAG IS CHANGE.
C
      DIMENSION MP(12),MK(12),ST(2),AT(2),LK(4)
      DIMENSION IM(120),ID(120),IH(120),IY(120),ITL(120)
      DIMENSION ITT(120),HE(120),AHE(120),AAHE(120)
      DIMENSION KTY(4,120,100),KKTH(4,120,100),HT(4,120,100)
      DIMENSION TLAG(4,120,100)
      INTEGER   AIM(120),AID(120),AIH(120),FLAG(120),FLAG1
      DO 4000 M=1,4
      KA=LK(M)
      DO 5000 J=1,89
      DO 6000 N=2,KA
      IABSYC=KTY(M,N,J)
      IABSHC=KKTH(M,N,J)
      CALL TRTIME(IYY,IMM,IDD,IHH,IABSYC,IABSHC,-1)
      ITL(N)=TLAG(M,N,J)
      HE(N)=HT(M,N,J)
      IH(N)=IHH
      ID(N)=IDD
      IM(N)=IMM
      IY(N)=IYY
6000  CONTINUE
      RY=1911+IYY
      FY=RY/4.
      KY=RY/4.
      IF((FY-KY).GT.0.001) GO TO 50
      MP(1)=0
      MP(2)=31
      MP(3)=60
      MP(4)=91
      MP(5)=121
      MP(6)=152
      MP(7)=182
      MP(8)=213
      MP(9)=244
      MP(10)=274
      MP(11)=305
      MP(12)=335
      MK(1)=31
      MK(2)=29
```

```
      MK(3)=31
      MK(4)=30
      MK(5)=31
      MK(6)=30
      MK(7)=31
      MK(8)=31
      MK(9)=30
      MK(10)=31
      MK(11)=30
      MK(12)=31
      GO TO 20
50    MP(1)=0
      MP(2)=31
      MP(3)=59
      MP(4)=90
      MP(5)=120
      MP(6)=151
      MP(7)=181
      MP(8)=212
      MP(9)=243
      MP(10)=273
      MP(11)=304
      MP(12)=334
      MK(1)=31
      MK(2)=28
      MK(3)=31
      MK(4)=30
      MK(5)=31
      MK(6)=30
      MK(7)=31
      MK(8)=31
      MK(9)=30
      MK(10)=31
      MK(11)=30
      MK(12)=31
20    DO 200 NA=1,KA
      NNH=IH(NA)+ITL(NA)
      NUD=NNH/24
      AIH(NA)=NNH-NUD*24
      NND=ID(NA)+NUD
      IF(NND.GT.MK(IM(NA))) THEN
                          AIM(NA)=IM(NA)+1
                          AID(NA)=NND-MK(IM(NA))
                      ELSE
                          AIM(NA)=IM(NA)
                          AID(NA)=NND
      END IF
200   CONTINUE
      DO 220 NB=1,KA
220   ITT(NB)=MP(AIM(NB))*24+(AID(NB)-1)*24+AIH(NB)
      II=1
88    IF(II.GT.KA) GO TO 99
C      WRITE(5,*)II
      LTT=ITT(II)
      L=0
      DO 600 JA=II+1,KA
      IF(ITT(JA).LE.LTT) THEN
                      LTT=ITT(JA)
```

```
                          L=JA
                      ELSE
                          GO TO 600
      END IF
600   CONTINUE
      IF(L.EQ.0) THEN
                  AHE(II)=HE(II)
              ELSE
                  SUMH=0.
                  DO 620 IP=II,L
620               SUMH = SUMH + HE(IP) * HE(IP)
                  HH=SQRT(SUMH)
                  DO 640 IJ=II,L
                  AHE(IJ)=HH
640               ITL(IJ)=-1
                  GO TO 500
      END IF
      II=II+1
      GO TO 88
500   II=L+1
      GO TO 88
99    FLAG(1)=100
      DO 1000 LP=2,KA
      IF(ITL(LP).EQ.-1) THEN
                        FLAG(LP)=100
                        GO TO 1000
                     ELSE
                        IF(ITL(LP-1).EQ.-1) THEN
                             FLAG(LP)=100
                             GO TO 1000
                                                    ELSE
                             IF(ITL(LP)-ITL(LP-1)) 1005,1010,1015
1005  FLAG(LP)=-1
      GO TO 1000
1010  FLAG(LP)=0
      GO TO 1000
1015  FLAG(LP)=1
      GO TO 1000
                        END IF
      END IF
1000  CONTINUE
      DO 1500 JI=1,KA
1500  AAHE(JI)=AHE(JI)
      LL=2
2800  IF(LL.GT.KA) GO TO 3000
      IF(FLAG(LL).EQ.1) THEN
                        FLAG1=1
                        GO TO 2400
                     ELSE
                        IF(FLAG(LL).EQ.-1) THEN
                              FLAG1=-1
                              GO TO 2400
                                                    ELSE
                              GO TO 2000
                        END IF
      END IF
2400  DO 2450 I=LL,KA
      IF(FLAG(I).EQ.FLAG1) GO TO 2450
```

```
2400  DO 2450 I=LL,KA
      IF(FLAG(I).EQ.FLAG1) GO TO 2450
```



```
      II=I-1
      GO TO 2460
2450  CONTINUE
      II=KA
2460  ST(1)=MP(IM(LL-1))*24+(ID(LL-1)-1)*24+IH(LL-1)
      ST(2)=MP(IM(II))*24+(ID(II)-1)*24+IH(II)
      AT(1)=MP(AIM(LL-1))*24+(AID(LL-1)-1)*24+AIH(LL-1)
      AT(2)=MP(AIM(II))*24+(AID(II)-1)*24+AIH(II)
      TONEY=((ST(2)-ST(1))/(AT(2)-AT(1)))**0.5
      DO 2900 NH=LL,II
2900  AAHE(NH)=AHE(NH)*TONEY
      LL=II+1
      GO TO 2800
2000  LL=LL+1
      GO TO 2800
3000  DO 300 NC=1,KA
300   HT(M,N,J)=AAHE(NC)
5000  CONTINUE
4000  CONTINUE
      RETURN
      END
      SUBROUTINE DIS(XA,YA,XB,YB,DDD)
      XX1=XA*111.324*COS(YA*3.14159/180.)
      YY1=YA*111.324
      XX2=XB*111.324*COS(YB*3.14159/180.)
      YY2=YB*111.324
      DDD=SQRT((XX1-XX2)**2.+(YY1-YY2)**2.)
      RETURN
      END
      SUBROUTINE EAREA(RR,RLU,RLL,DA,CD)
      DIMENSION R(2),A(2)
      AL=111.12
      R(1)=RLL
      R(2)=RLU
      IF(CD.GT. 90.AND.CD.LE.180) GO TO 101
      IF(CD.GT.180.AND.CD.LE.270) GO TO 102
      IF(CD.GT.270.AND.CD.LE.360) GO TO 103
      GO TO 100
101   CD=180.-CD
      GO TO 100
102   CD=CD-180.
      GO TO 100
103   CD=360.-CD
100   SCL=55.6*(SIND(CD)+COSD(CD))
      SSCL=55.6*ABS(COSD(CD)-SIND(CD))
      DO 50 K=1,2
      DR=ABS(R(K)-RR)
      IF(CD.LT.0.05.OR.(90.-CD).LT.0.05) GO TO 500
      IF(DR.GE. SCL) GO TO 52
      IF(DR.GE.SSCL) GO TO 53
      A(K)=((SSCL-DR)*AL)/COSD(CD)+AL*AL*TAND(CD)/2.
      GO TO 50
53    A(K)=((SCL-DR)/(AL*SIND(CD)))**2.*(AL*AL*TAND(CD))/2.
      GO TO 50
52    A(K)=0.
      GO TO 50
500   IF(DR.LT.55.6) GO TO 501
      A(K)=0.
```

```
      GO TO 50
501   A(K)=(55.6-OR)*AL
50    CONTINUE
      IF(R(1).LE.RR.AND.R(2).LE.RR) GO TO 201
      IF(R(1).LE.RR.AND.R(2).GE.RR) GO TO 202
      TA=A(1)-A(2)
      GO TO 200
201   TA=A(2)-A(1)
      GO TO 200
202   TA=AL*AL-A(1)-A(2)
200   DA=(TA*DA)/(AL*AL)
      RETURN
      END
```

附　錄 II　　可用於個人電腦之波浪預報系統程式

洪　憲　忠

本附錄乃針對 IBM 個人電腦 (IBM PC/XT) 而設計之本計劃程式，由於使用標準的 FORTRAN 77 電腦語言，故此程式可輕易地轉移至 VAX-11 780 電腦上使用。

為了使程式可在 IBM PC/XT 上使用，因此，將波浪預報系統之程式進行分割再整合。其各程式之功能概述如下：

1. MONSOON.FOR:

   求季風風場下波浪點之波高及週期。

2. TWINDW.FOR:

   求颱風 10 R 範圍內波浪點之波高及週期。

3. TSWELL.FOR:

   求由於湧浪造成之波浪點波高及週期。

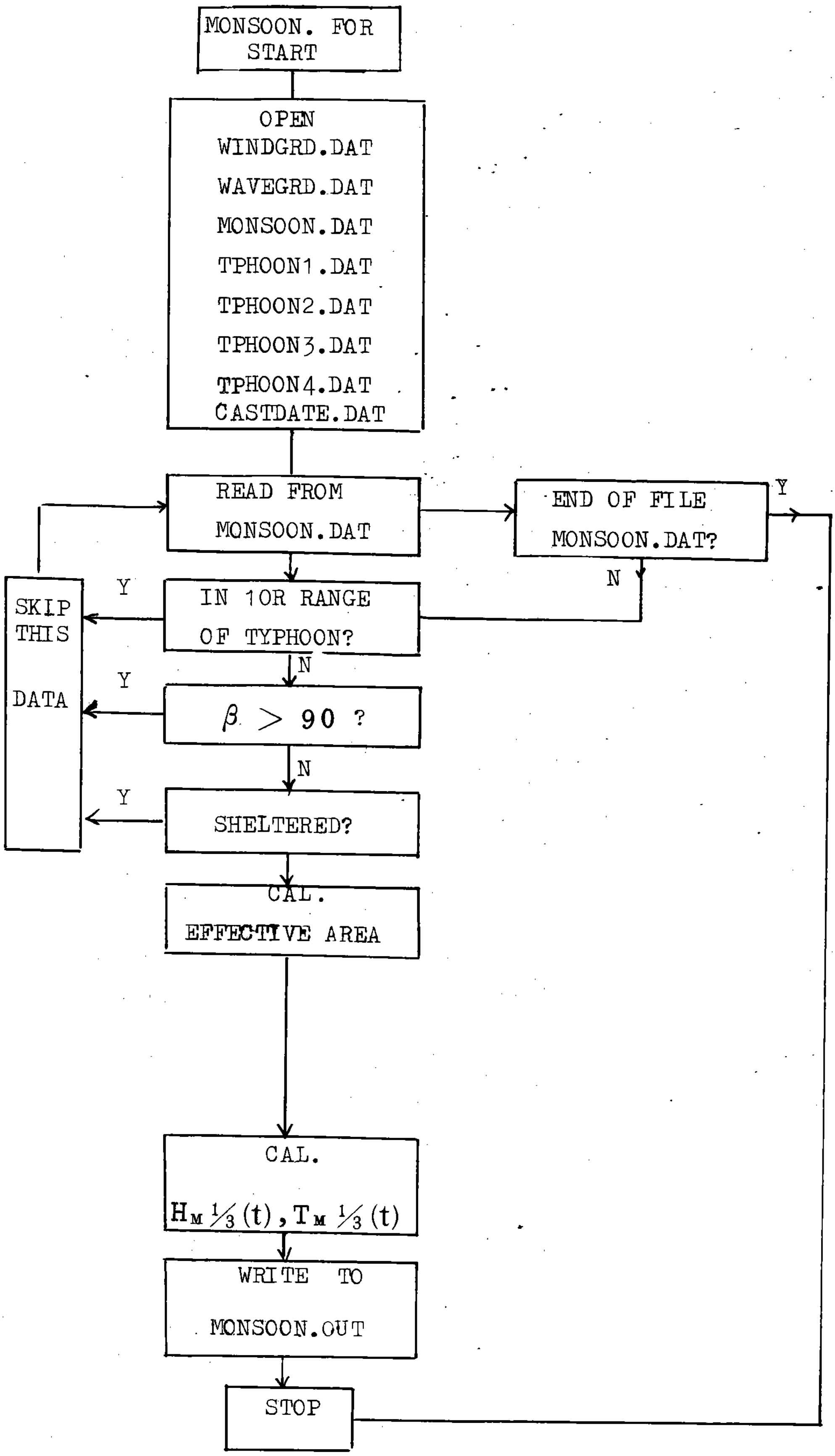
4. SUMCWB.FOR:

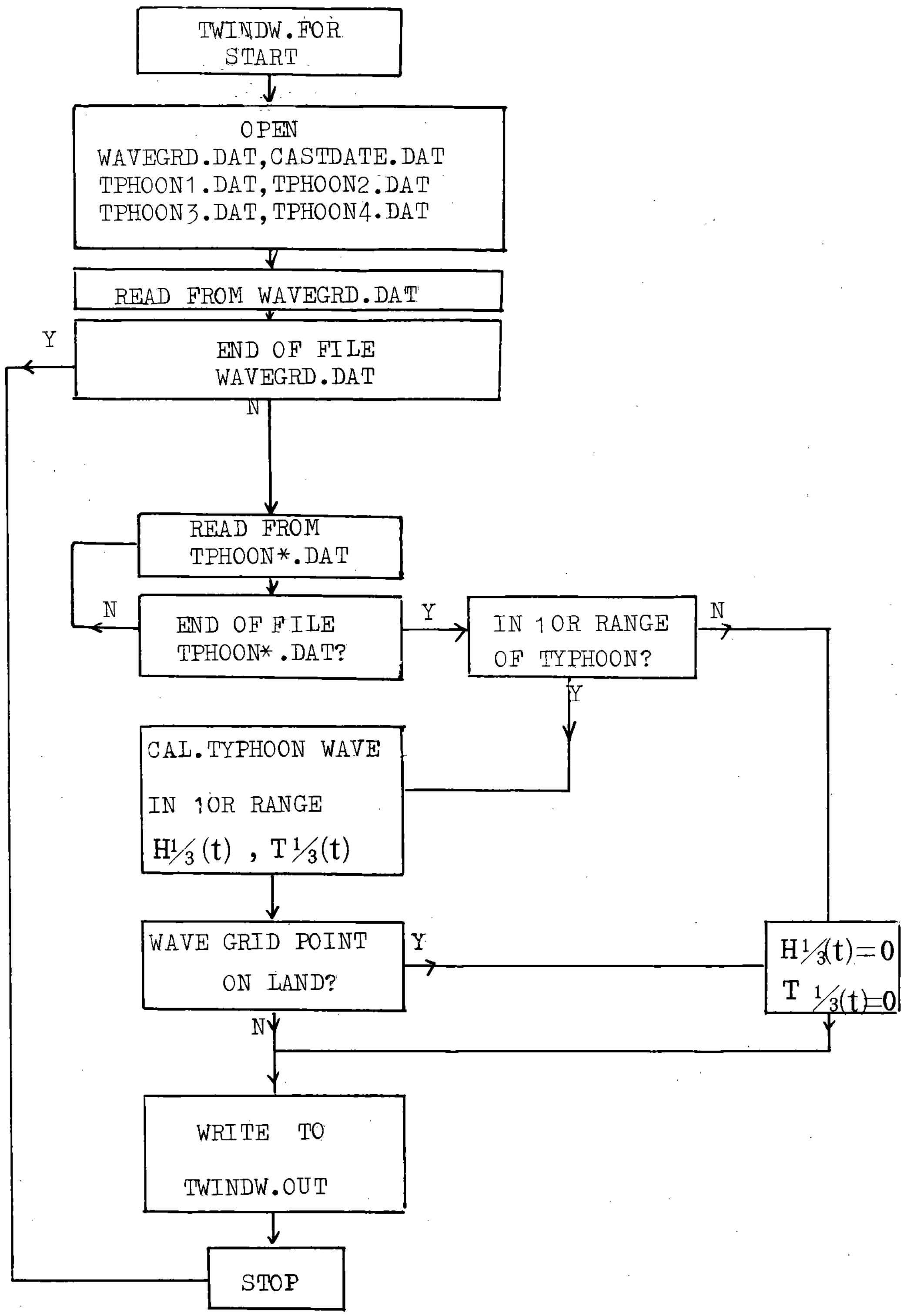
   將季風、颱風風浪、湧浪三者整合而得三者共同作用下波浪點之波高及週期。

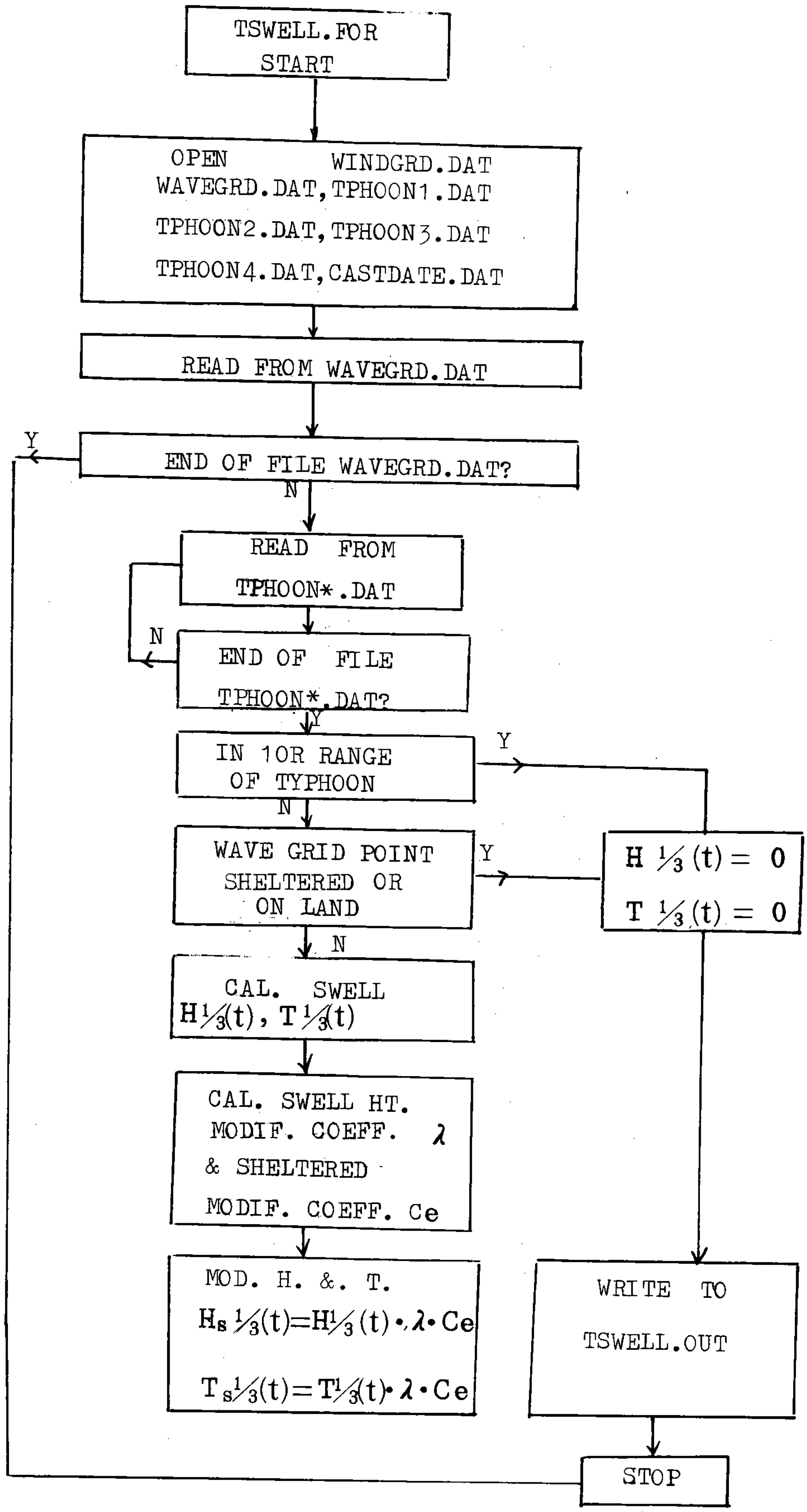
5. CWBLIB.FOR:

   提供前述各程式所須之副程式程式庫。

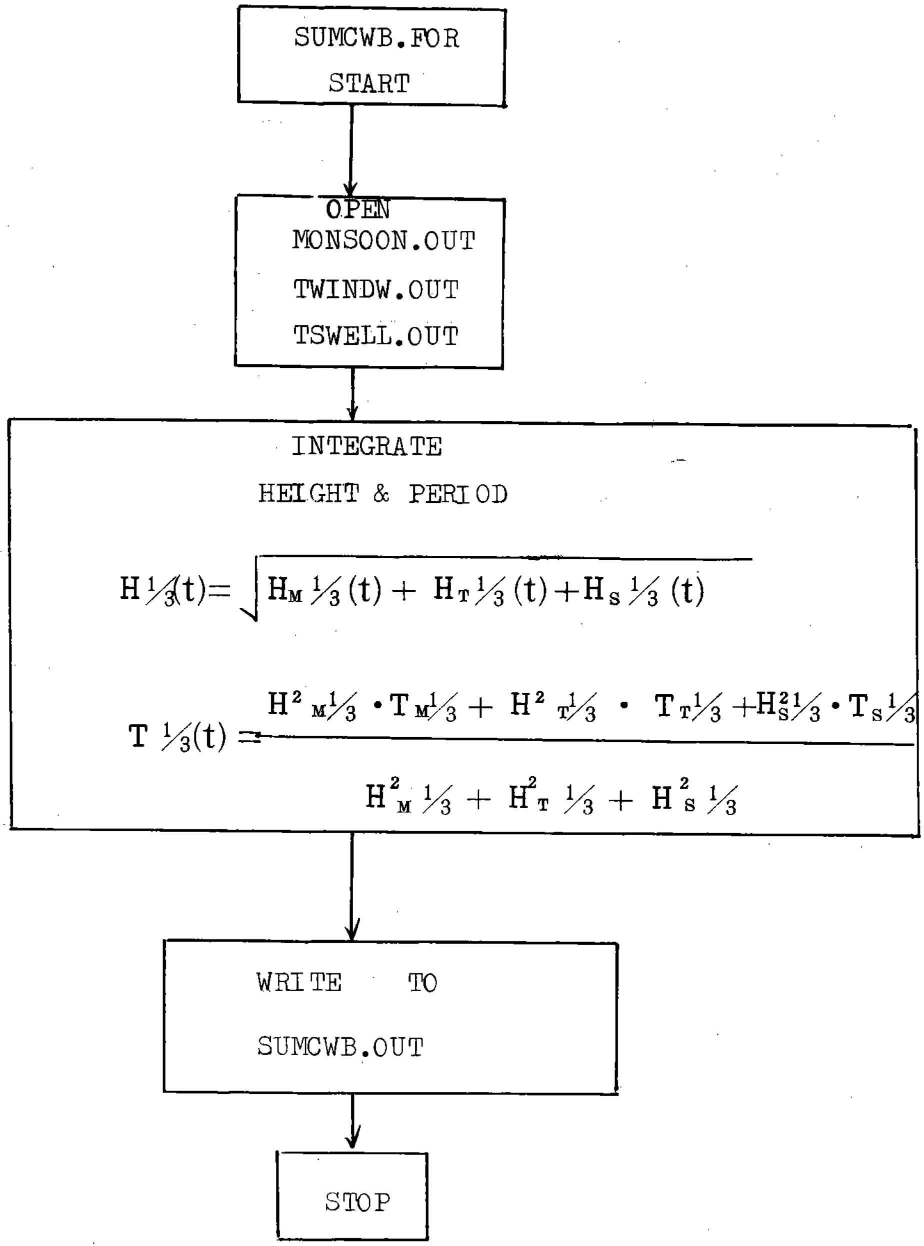
平常，系統運作，須用到之主程式有 MONSOON.FOR、TWINDW.FOR、TSWELL.FOR 及 SUMCWB.FOR 等四者，其簡要流程圖各如下述：


MONSOON. FOR
START
OPEN
WINDGRD.DAT
WAVEGRD.DAT
MONSOON.DAT
TPHOON1.DAT
TPHOON2.DAT
TPHOON3.DAT
TPHOON4.DAT
CASTDATE.DAT
READ FROM
MONSOON.DAT
END OF FILE
MONSOON.DAT?
Y
N
SKIP
THIS
DATA
Y
IN 10R RANGE
OF TYPHOON?
N
Y
β > 90 ?
N
Y
SHELTERED?
CAL.
EFFECTIVE AREA
CAL.
H_M 1/3 (t), T_M 1/3 (t)
WRITE TO
MONSOON.OUT
STOP


TWINDW.FOR
START
OPEN
WAVEGRD.DAT,CASTDATE.DAT
TPHOON1.DAT,TPHOON2.DAT
TPHOON3.DAT,TPHOON4.DAT
READ FROM WAVEGRD.DAT
END OF FILE
WAVEGRD.DAT
Y
N
READ FROM
TPHOON*.DAT
END OF FILE
TPHOON*.DAT?
N
Y
IN 1OR RANGE
OF TYPHOON?
N
Y
CAL.TYPHOON WAVE
IN 1OR RANGE
H1/3(t) , T1/3(t)
WAVE GRID POINT
ON LAND?
Y
N
H1/3(t)=0
T 1/3(t)=0
WRITE TO
TWINDW.OUT
STOP



TSWELL.FOR
START
OPEN WINDGRD.DAT
WAVEGRD.DAT, TPHOON1.DAT
TPHOON2.DAT, TPHOON3.DAT
TPHOON4.DAT, CASTDATE.DAT
READ FROM WAVEGRD.DAT
END OF FILE WAVEGRD.DAT?
Y
N
READ FROM
TPHOON*.DAT
END OF FILE
TPHOON*.DAT?
N
Y
IN 1OR RANGE
OF TYPHOON
Y
N
WAVE GRID POINT
SHELTERED OR
ON LAND
Y
N
H 1/3 (t) = 0
T 1/3 (t) = 0
CAL. SWELL
H1/3(t), T1/3(t)
CAL. SWELL HT.
MODIF. COEFF. λ
& SHELTERED
MODIF. COEFF. Ce
MOD. H. &. T.
Hs 1/3(t)=H1/3 (t) · λ · Ce
Ts1/3(t)=T1/3(t) · λ · Ce
WRITE TO
TSWELL.OUT
STOP


SUMCWB.FOR
START
OPEN
MONSOON.OUT
TWINDW.OUT
TSWELL.OUT
INTEGRATE
HEIGHT & PERIOD
$H_{1/3}(t)=\sqrt{H_{M 1/3}(t)+H_{T 1/3}(t)+H_{S 1/3}(t)}$
$T_{1/3}(t)=\frac{H^2_{M 1/3}\cdot T_{M 1/3}+H^2_{T 1/3}\cdot T_{T 1/3}+H^2_{S 1/3}\cdot T_{S 1/3}}{H^2_{M 1/3}+H^2_{T 1/3}+H^2_{S 1/3}}$
WRITE TO
SUMCWB.OUT
STOP

各程式列印如后：

```
C
C       PROGRAM MONSOON.FOR
C
C       NG1: TOTAL GRID NO OF WIND FIELD.
C       NG2: TOTAL GRID NO OF WAVE FIELD.
C       UNIT: DISTANCE(KM),VELOCITY(M/S),WAVE HEIGHT(M)
C             WAVE PERIOD(SEC),TIME DURATION(HR)
C       NMAX: MAX. DATA NO FOR CURVE FITTING.
C       MMAX: MAX. POLYNOMIAL DEGREES FOR CURVE FITTING.
C       NTMAX: MAX. TIME NO.
C       NGMAX1: MAX. WIND GRID NO /PER TIME NO.
C       NGMAX2: MAX. WAVE GRID NO.
        PARAMETER (NPHOON=4)
        PARAMETER (NMAX=40,MMAX=10)
        PARAMETER (NTMAX=100,NGMAX1=961,NGMAX2=1)
        REAL LON1(NGMAX1),LAT1(NGMAX1),MAXF,LON2(NGMAX2),LAT2(NGMAX2)
        INTEGER TD,TYY,TMM,TDD,THR
        DIMENSION H13(NTMAX),T13(NTMAX),XFIT(NTMAX),YFIT(NTMAX)
        DIMENSION ATB(MMAX),W(NMAX),NYY3(NTMAX),NMON3(NTMAX)
        DIMENSION NDD3(NTMAX),NHR3(NTMAX)
        DIMENSION DDIST(NGMAX1),CUSI(NGMAX2)
        DIMENSION AREA(34),RDD(2),AI(2),RI(2)
        DIMENSION CCX1(NGMAX1),CCY1(NGMAX1)
        DIMENSION CCX2(NGMAX2),CCY2(NGMAX2)
        CHARACTER NAME2*15,NAME3*15,MONSOON*15
C       AREA: UNIT(KM**2)
        DATA AREA/9*0.,12141.610,12100.998,12056.530,12008.190,
     *       11954.620,11897.050,11839.210,11778.530,11711.180,
     *       11639.610,11566.310,11489.960,11409.170,11323.810,
     *       11236.520,11145.880,11051.750,10954.060,10852.820,
     *       10746.410,10638.940,10530.360,10416.390,10299.700,
     *       10177.280/

        WRITE(*,*) 'ENTER MONSOON INPUT DATA FILE ?'
        READ(6,22) MONSOON
 22     FORMAT(A15)

        OPEN(UNIT=1,FILE='WINDGRD.DAT',STATUS='OLD')
        OPEN(UNIT=2,FILE=MONSOON,STATUS='OLD')
        OPEN(UNIT=3,FILE='CASTDATE.DAT',STATUS='OLD')
        OPEN(UNIT=4,FILE='TPHOON1.DAT',STATUS='OLD')
        OPEN(UNIT=5,FILE='TPHOON2.DAT',STATUS='OLD')
        OPEN(UNIT=6,FILE='TPHOON3.DAT',STATUS='OLD')
        OPEN(UNIT=7,FILE='TPHOON4.DAT',STATUS='OLD')
        OPEN(UNIT=8,FILE='WAVEGRD.DAT',STATUS='OLD')
        OPEN(UNIT=10,FILE='MONSOON.OUT',STATUS='NEW')
        OPEN(UNIT=11,FILE='COEFF.OUT',STATUS='OLD')
        OPEN(UNIT=13,FILE='CUSI.DAT',STATUS='OLD')
C       (LON.LAT.) OF CARTESIAN COORDINATE ORIGIN (XA,YA) TO BE (100,5).
        XA=100.
        YA=5.

        NG1=1
        REWIND 1
        READ(1,*)
 33     READ(1,*,END=34) I1,LON1(I1),LAT1(I1)
C       CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C       CCX2: CARTESIAN X-COORDINATE OF WIND GRID POINT.
```

```
C       CCY2: CARTESIAN Y-COORDINATE OF WIND GRID POINT.
        CALL LONLTD(XA,YA,LON1(I1),YA,CCX1(I1))
        CALL LONLTD(XA,YA,XA,LAT1(I1),CCY1(I1))
        NG1=NG1+1
        GO TO 33
 34     NG1=NG1-1
        REWIND 1
        IF(NG1 .NE. NGMAX1) THEN
           WRITE(*,*) 'PLS CHECK ALLOWABLE WIND GRID NO DIMENSION'
        END IF

        NG2=1
        REWIND 8
        READ(8,*)
  36    READ(8,*,END=37) I2,LON2(I2),LAT2(I2)
C 36     READ(8,*,END=37) I2,LON2(I2),LAT2(I2),CUSI(I2)
C       CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C       CCX2: CARTESIAN X-COORDINATE OF WAVE GRID POINT.
C       CCY2: CARTESIAN Y-COORDINATE OF WAVE GRID POINT.
        CALL LONLTD(XA,YA,LON2(I2),YA,CCX2(I2))
        CALL LONLTD(XA,YA,XA,LAT2(I2),CCY2(I2))
        NG2=NG2+1
        GO TO 36
 37     NG2=NG2-1
        REWIND 8
        IF(NG2 .GT. NGMAX2) THEN
           WRITE(*,*) 'PLS CHECK ALLOWABLE WAVE GRID NO DIMENSION'
        END IF

        DO 343 I2=1,NG2
                READ(13,*)
                READ(13,*) ID,CUSI(I2)
                IF(I2 .NE. ID) THEN
                   WRITE(*,*) 'PLS CHECK FILE CUSI.DAT.'
                END IF
 343    CONTINUE

        IF(NT .GT. NTMAX ) THEN
           WRITE(*,*) 'TOTAL TIME NO IS OVER ALLOWABLE.'
        END IF

        REWIND 11
        READ(11,*)
        READ(11,*) C3,C4
        REWIND 11

        REWIND 3
        READ(3,*)
        NW=1
 26     READ(3,*,END=28) NYY3(NW),NMON3(NW),NDD3(NW),NHR3(NW)
        NW=NW+1
        GO TO 26
 28     NW=NW-1

        REWIND 12
        DO 80 I=1,NG2
        DO 82 J=1,NG1
        CALL LONLTD(LON1(J),LAT1(J),LON2(I),LAT2(I),DDIST(J))
```

```
 82     CONTINUE
C       THE JTH FIELD DATA OF THE ITH RECORD IN FILE 12 REPRESENTS
C           THE DISTANCE OF ITH WAVE GRID POINT TO JTH WIND GRID POINT.
        WRITE(12) (DDIST(J),J=1,NG1)
 80     CONTINUE
        REWIND 12

C       CHANGE H13(CM) INTO H13(M).
C       CHANGE T13(10 SEC) INTO T13(SEC).
        H13(NW)=H13(NW)/100.
        T13(NW)=T13(NW)/10.
C       NW: FORECASTED WAVE TIME NO.
        DO 1000 I1=1,NW
           REWIND 12

C           WRITE(10,123) I1
           WRITE(10,132)
           WRITE(10,134) NYY3(I1),NMON3(I1),NDD3(I1),NHR3(I1)
C          WRITE(10,*)
           WRITE(10,136)

           WRITE(*,*)
           WRITE(*,*) ' FORECAST WAVE NO=',I1
           WRITE(*,132)
           WRITE(*,134) NYY3(I1),NMON3(I1),NDD3(I1),NHR3(I1)
           WRITE(*,*)
           WRITE(*,136)

C 123       FORMAT('1','FORECAST WAVE NO=',I2)
 132       FORMAT(1X,' YY',2X,'MM',1X,'DD',1X,'HR')
 134       FORMAT(1X,I4,3I3)
 136       FORMAT(3X,'PT.',5X,'LON',8X,'LAT',7X,'H13(CM)',
     1            4X,'T13(S)')

        DO 1010 K=1,NG2
C          WRITE(*,*) 'WAVE GRID POINT=',K
           CXM=CCX2(K)
           CYM=CCY2(K)
           READ(12) (DDIST(JJ),JJ=1,NG1)
           SH=0.
           MAXF=0
           SUA=0
           SA=0
 112       READ(2,*,END=114) NYY,NMON,NDD,NHR
           READ (2,*)
           KYY3=NYY3(I1)
           KMON3=NMON3(I1)
           KDD3=NDD3(I1)
           KHR3=NHR3(I1)
           CALL TIMDUR(NYY,NMON,NDD,NHR,KYY3,KMON3,KDD3,KHR3,TD)
           IF(TD .LT. 0) THEN
             GO TO 114
           END IF
           DO 120 J=1,NG1
             WRITE(*,*) 'WIND GRID NO=',J
             DO 200 IP=1,NPHOON
             IF(IP .EQ. 1) READ(4,*,END=200)
             IF(IP .EQ. 2) READ(5,*,END=200)
```

```
      IF(IP .EQ. 3) READ(6,*,END=200)
      IF(IP .EQ. 4) READ(7,*,END=200)
220   IF(IP .EQ. 1) THEN
        READ(4,*,END=200) TYY,TMM,TDD,THR,TLON,TLAT,
     1                    PD,VF,R10,R7,TMANG
      ELSE IF(IP .EQ. 2) THEN
        READ(5,*,END=200) TYY,TMM,TDD,THR,TLON,TLAT,
     1                    PD,VF,R10,R7,TMANG
      ELSE IF(IP .EQ. 3) THEN
        READ(6,*,END=200) TYY,TMM,TDD,THR,TLON,TLAT,
     1                    PD,VF,R10,R7,TMANG
      ELSE IF(IP .EQ. 4) THEN
        READ(7,*,END=200) TYY,TMM,TDD,THR,TLON,TLAT,
     1                    PC,VF,R10,R7,TMANG
      END IF
      CALL LONLTD(TLON,TLAT,LON1(J),LAT1(J),DIST1)
C     WRITE(*,*) 'DIST1=',DIST1
C      WRITE(*,*) 'R7=',R7
C      WRITE(*,*) 'NYY,TYY=',NYY,TYY
C      WRITE(*,*) 'NMON,TMM=',NMON,TMM
C      WRITE(*,*) 'NDD,TDD=',NDD,TDD
C      WRITE(*,*) 'NHR,THR=',NHR,THR
      IF(NYY.EQ.TYY .AND. NMON.EQ.TMM .AND. NDD.EQ.TDD
     1  .AND. NHR.EQ.THR .AND. DIST1 .LE. R7) THEN
         READ(2,*) NPT,RNUL,RNUL,WU,WD
         GO TO 120
      END IF
      GO TO 220
200   CONTINUE
      REWIND 4
      REWIND 5
      REWIND 6
      REWIND 7
      LATJ=INT(LAT1(J))
C     WRITE(*,*) 'LAT1(J)=',LAT1(J)
C     WRITE(*,*) 'LATJ=',LATJ
C     WRITE(*,*) 'LATJ,AREA(LATJ)=',LATJ,AREA(LATJ)
C      WU: WIND SPEED (M/S).
C      WD: WIND DIRECTION (DEGREE,FROM +X AXIS).
C      READ(2,*) NPT,RNUL,RNUL,WU,WD
C      WRITE(*,*) 'LON1(J),LAT1(J) =',LON1(J),LAT1(J)
C      WRITE(*,*) 'NPT,WU=',NPT,WU,WD
C      WRITE(*,*) 'DIST= ',DDIST(J)
C      WRITE(*,*) 'WU= ',WU
C      WRITE(*,*) 'TD= ',TD
C      WRITE(*,*) 'DIST-WU*3600.*TD/2./1000.= ',
C    * DDIST(J)-WU*3600.*TD/2./1000.
C     1.8=3600/2./1000.
      WRITE(*,*) 'THE DISTANCE DIFFERENCE =',D1
      CALL ANGLE(CXM,CYM,CCX1(J),CCY1(J),ANG)
C     A1: THE ANGLE BETWEEN WIND DIRECTION AND DIRECTION
C             FROM WIND GRID POINT TO MEASURING STATION.
      A1=ABS(ANG-WD)
C     WRITE(*,*) 'THE BETA ANGLE =',A1
      IF(A1.GT.90) GO TO 120
      CALL SHELT(CXM,CYM,CCX1(J),CCY1(J),NCODE,MAXITR)
C     WRITE(*,*) 'NCODE= ',NCODE
      IF(NCODE .EQ. 0) THEN
```

```
C               WRITE(*,*) 'WIND GRID NO=',J
C                 WRITE(*,*) 'CCX2,CCY2,CCX1,CCY1',CXM,CYM,CCX1(J),CCY1(J)
C               END IF
                IF(NCODE .GE. 1) GO TO 120
                IF(DDIST(J) .GT. MAXF) MAXF=DDIST(J)
                IF(LON1(J).EQ.LON2(K) .AND. LAT1(J).EQ.LAT2(K)) GO TO 120
C
C               CAL. EFFECTIVE AREA.
C
                RI(1)=WU*TD*1.8
C               TD+3.: MONSOON FILE'S DATA'S TIME LAG=3 HR.
                RI(2)=WU*(TD+3.)*1.8
                IF(ANG .LE. 180.) THEN
C               THITA: DEGREES
                  THITA=ABS(ANG-90.)
                ELSE
                  THITA=ABS(270.-ANG)
                END IF
C               THITA2: RADIAN
                THITA2=0.0174533*THITA
                COS1=COS(THITA2)
                SIN1=SIN(THITA2)
                TAN1=TAN(THITA2)
                COS2=COS1+SIN1
                COS3=ABS(COS1-SIN1)
                GL=SQRT(AREA(LATJ))
                GL2=0.5*GL
                DO 62 IZ=1,2
                  RDD(IZ)=ABS(RI(IZ)-DDIST(J))
                  IF(THITA.EQ.0 .OR. THITA.EQ.90.) THEN
                    IF(RDD(IZ).GE.GL2) THEN
                      AI(IZ)=0.
                    ELSE
                      AI(IZ)=(GL2-RDD(IZ))*GL
                    END IF
                  ELSE IF(RDD(IZ).GE.GL2*COS2) THEN
                    AI(IZ)=0.
                  ELSE IF(RDD(IZ).LT.GL2*COS2 .AND. RDD(IZ).GE.GL2*COS3)
     1                 THEN
                         AI(IZ)=(GL**2)/2.*TAN1*((GL2*COS2-RDD(IZ))/
     1                     (GL*SIN1))**2
                       ELSE
                         AI(IZ)=(GL2*COS3-RDD(IZ))*GL/COS1+(GL**2)/
     1                          2.*TAN1
                  END IF
   62           CONTINUE
                IF(RI(1).LE.DDIST(J).AND.RI(2).LE.DDIST(J)) THEN
                  EAREA=AI(2)-AI(1)
                ELSE IF(RI(1).LT.DDIST(J).AND.RI(2).GT.DDIST(J)) THEN
                  EAREA=GL**2-AI(2)-AI(1)
                ELSE IF(RI(1).GT.DDIST(J).AND.RI(2).GT.DDIST(J)) THEN
                  EAREA=AI(1)-AI(2)
                END IF

                SUA=SUA+WU*EAREA
C               WRITE(*,*) 'SUA=',SUA
                SA=SA+EAREA
C               WRITE(*,*) 'SA=',SA
```

```
             WU2=WU**2
C            0.00008=0.08/1000.
C            0.0174533=3.14159/180.
             SH=SH+WU2*(COS(A1*0.0174533)**2)*
     *       EXP(-0.08*DDIST(J)/WU2)*EAREA/DDIST(J)*1000.
 120       CONTINUE
 100    GO TO 112
C          UBAR: UNIT (M/SEC).
C          MAXF: (KM).
C          WRITE(*,*) 'SUA=',SUA
C          WRITE(*,*) 'SA=',SA
 114       IF(SA .EQ. 0 .OR. SUA .EQ. 0 .OR. MAXF .EQ. 0) GO TO 999
           UBAR=SUA/SA
C          0.64114=2*3.14159/9.8
           UBAR2=UBAR**2
C          T13:(SEC)
           T13(K)=0.64114*C3*((9800.*MAXF/UBAR2)**C4)*UBAR
C          0.8163265=8/9.8
C          H13:(M)
           H13(K)=(0.8163265*CUSI(K)*SH/T13(K))**0.5
 999       REWIND 2
            WRITE(10,138) K,LON2(K),LAT2(K),100.*H13(K),T13(K)
            WRITE(*,138) K,LON2(K),LAT2(K),100.*H13(K),T13(K)
 138        FORMAT(1X,I4,4(1X,F10.3))
 1010   CONTINUE
 1000   CONTINUE
 130       FORMAT('DATE:',4(2X,I4))
        STOP
        END
C-----------------------------------------------------------------------
```

```
C       PROGRAM TWINDW.FOR (ONLY CONSIDER WIND WAVE OF TYPHOON).
C       NG2MAX: ALLOWABLE MAX. GRID NO OF WAVE FIELD.
C       NPHOON: ALLOWABLE MAX. NO      OF TYPHOON.
        PARAMETER (NG2MAX=200,NPHOON=4)
        REAL LON2(NG2MAX),LAT2(NG2MAX),LON22,LAT22
        INTEGER TYY,TMM,TDD,THR,CYY,CMM,CDD,CHR
        DIMENSION CCX2(NG2MAX),CCY2(NG2MAX)
        OPEN(UNIT=1,FILE='WAVEGRD.DAT',STATUS='OLD')
        OPEN(UNIT=2,FILE='TPHOON1.DAT',STATUS='OLD')
        OPEN(UNIT=3,FILE='TPHOON2.DAT',STATUS='OLD')
        OPEN(UNIT=4,FILE='TPHOON3.DAT',STATUS='OLD')
        OPEN(UNIT=5,FILE='TPHOON4.DAT',STATUS='OLD')
        OPEN(UNIT=6,FILE='TWINDW.OUT',STATUS='NEW')
        OPEN(UNIT=10,FILE='CASTDATE.DAT'   ,STATUS='OLD')

        NG2=1
        REWIND 1
        READ(1,*)
36      READ(1,*,END=37) I2,LON2(I2),LAT2(I2)
        NG2=NG2+1
        GO TO 36
37      NG2=NG2-1
        REWIND 1

C       NDATE: TIME NO FOR FORECASTING WAVE.
        READ(10,*)
        NDATE=1
33      READ(10,*,END=34) CYY,CMM,CDD,CHR
        NDATE=NDATE+1
        GO TO 33
34      NDATE=NDATE-1
        REWIND 10
        READ(10,*)
        READ(1,*)
        DO 128 JG=1,NG2
          READ(1,*) J,LON2(J),LAT2(J)
128     CONTINUE
        XA=100.
        YA=5.
        LON22=121.
        LAT22=23.
        SHH=0.
        STT=0.
        DO 888 JJ=1,NDATE
        READ(10,*) CYY,CMM,CDD,CHR
        WRITE(6,132)
        WRITE(6,134) CYY,CMM,CDD,CHR
        WRITE(6,136)
        WRITE(*,*)
        WRITE(*,*)'--------------------------------------------------------'
        WRITE(*,*) 'FORECAST WAVE NO=',JJ
        WRITE(*,132)
        WRITE(*,134) CYY,CMM,CDD,CHR
        WRITE(*,*)
        WRITE(*,136)
C 123   FORMAT('1','FORECAST WAVE NO =',I2)
 132    FORMAT(1X,' YY',2X,'MM',1X,'DD',1X,'HR')
 134    FORMAT(1X,I4,3I3)
```

```
136     FORMAT(3X,'PT.',5X,'LON',8X,'LAT',7X,'H13(CM)',
     1        4X,'T13(S)')
        DO 120 J=1,NG2
C         WRITE(*,*) 'NG2= ',J
          IF(LON2(J).EQ.LON22 .AND. LAT2(J).EQ.LAT22) THEN
            H13=0.
            T13=0.
            GO TO 111
          END IF
          CALL LONLTO(XA,YA,LON22,YA,CLON22)
          CALL LONLTO(XA,YA,XA,LAT22,CLAT22)
C            CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C            (LON.LAT.) OF CARTESIAN COORDINATE ORIGIN (XA,YA) TO BE (100,5).
C            CCX2: CARTESIAN X-COORDINATE OF WIND GRID POINT.
C            CCY2: CARTESIAN Y-COORDINATE OF WIND GRID POINT.
             CALL LONLTO(XA,YA,LON2(J),YA,CCX2(J))
             CALL LONLTO(XA,YA,XA,LAT2(J),CCY2(J))
          CALL SHELT(CLON22,CLAT22,CCX2(J),CCY2(J),NCODE,MAXITR)
        IF(NCODE .EQ. 0) THEN
          H13=0.
          T13=0.
          GO TO 111
        END IF
        DO 200 I1=1,NPHOON
C         WRITE(*,*) 'NPHOON= ',I1
        IF(I1 .EQ. 1) READ(2,*,END=200)
        IF(I1 .EQ. 2) READ(3,*,END=200)
        IF(I1 .EQ. 3) READ(4,*,END=200)
        IF(I1 .EQ. 4) READ(5,*,END=200)
C         TMANG:THE DIRECTION(DEGREE,WITH+X AXIS)THAT TYPHOON MOVES.
220         IF(I1.EQ.1)THEN
            READ(2,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,TMANG
          ELSE IF(I1.EQ.2) THEN
            READ(3,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,THANG
          ELSE IF(I1.EQ.3) THEN
            READ(4,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,TMANG
          ELSE IF(I1.EQ.4) THEN
            READ(5,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,TMANG
          END IF
C         WRITE(*,*) 'TYY',TYY,'TMM=',TMM,'TDD=',TDD,'THR=',THR
C         WRITE(*,*) 'TLON=',TLON,'TLAT=',TLAT
C         WRITE(*,*) 'PO=',PO,'VF=',VF
C         WRITE(*,*) 'R10=',R10,'R7=',R7,'TMANG=',TMANG
          CALL LONLTO(TLON,TLAT,LON2(J),LAT2(J),DD)
C         WRITE(*,*) 'DD,R7=',DD,R7
          IF(CYY.EQ.TYY .AND. CMM.EQ.TMM .AND. CDD.EQ.TDD .AND.
     1       CHR.EQ.THR .AND.  DD.LE.R7) THEN
          DP=29.92-0.02953*PO
C         WRITE(*,*) 'DP=',DP
C         WRITE(*,*) 'TLAT=',TLAT
          CALL FK(TLAT,RF,RK)
C         WRITE(*,*) 'RF,RK=',RF,RK
C         RMAX (N.MILE)
C         WAVE HEIGHT: (FT)
```


0057

```
C         WAVE PERIOD: (S)
          RMAX=R7/10.*0.53996
C         WRITE(*,*) 'RMAX=',RMAX
          UR=RK*(DP**0.5)-0.5*RF*RMAX
C         WRITE(*,*) 'UR=',UR
          URS=0.865*UR
C         WRITE(*,*) 'URS=',URS
C           CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C           (LON.LAT.) OF CARTESIAN COORDINATE ORIGIN (XA,YA) TO BE (100,5).
C           CCX2: CARTESIAN X-COORDINATE OF WIND GRID POINT.
C           CCY2: CARTESIAN Y-COORDINATE OF WIND GRID POINT.
C         CTLON: CARTESIAN X-COORDINATE OF TYPHOON CENTER.
C         CTLAT: CARTESIAN Y-COORDINATE OF TYPHOON CENTER.
          CALL LONLTC(XA,YA,TLON,YA,CTLON)
          CALL LONLTC(XA,YA,XA,TLAT,CTLAT)
            CALL ANGLE(CCX2(J),CCY2(J),CTLON,CTLAT,TANG)
            CALL HT1(TANG,TMANG,VF,URS,RF,RMAX,UR,DP,DD,
     1                FRUR,SRR,HRM,HSRM)
            CALL PERIOD(FRUR,SRR,UR,DU,HSRM,TSRM)
            GO TO 222
          END IF
          GO TO 220
 222      SHH=SHH+HSRM**2
          STT=STT+TSRM*(HSRM**2)
C         WRITE(*,*) 'SHH=',SHH
C         WRITE(*,*) 'STT=',STT
 200    CONTINUE
        IF(SHH .EQ. 0.) THEN
        T13=0.
        H13=0.
        GO TO 111
        END IF
C       WRITE(*,*) 'AFTER 200,SHH=',SHH
        T13=STT/SHH
        H13=SHH**0.5
 111    WRITE(6,138) J,LON2(J),LAT2(J),30.48*H13,T13
        WRITE(*,138) J,LON2(J),LAT2(J),30.48*H13,T13
 138    FORMAT(1X,I4,4(1X,F10.3))
        SHH=0.
        STT=0.
        REWIND 2
        REWIND 3
        REWIND 4
        REWIND 5
 120      CONTINUE
 888    CONTINUE
        STOP
        END
C-----------------------------------------------------------------
        SUBROUTINE FK(FI,RF,RK)
C       FI:  INPUT LATITUDE OF TYPHOON CENTER.
C       FFI:  LATITUDE ARRAY OF TYPHOON CENTER.
C       FIF: F IN CHART.
C       FIK: K IN CHART.
        PARAMETER (N1=9)
        DIMENSION FFI(N1),FIF(N1),FIK(N1)
        DATA FFI/20.,22.5,25.,27.5,30.,32.5,35.,37.5,40.0/
        DATA FIF/0.18,0.20,0.22,0.24,0.26,0.28,0.30,0.32,0.34/
```

```
      DATA FIK/67.,67.,67.,66.,66.,66.,66.,65.,64./
      CALL SPLING(N1,FFI,FIF,FI,RF)
      CALL SPLING(N1,FFI,FIK,FI,RK)
      RETURN
      END
C-----------------------------------------------------------
      SUBROUTINE KPRAN(FRUR,RK1)
C     FRUR: FR/UR IN CHART
      PARAMETER (N1=51)
      DIMENSION FRU(N1),AKP1(N1)
      DATA FRU/0.000,0.005,0.010,0.015,0.020,0.025,0.030,0.035,
     *          0.040,0.045,0.050,0.055,0.060,0.065,0.070,0.075,
     *          0.080,0.085,0.090,0.095,0.100,0.110,0.120,0.130,
     *          0.140,0.150,0.160,0.170,0.180,0.190,0.200,0.210,
     *          0.220,0.230,0.240,0.250,0.260,0.270,0.280,0.290,
     *          0.300,0.310,0.320,0.330,0.340,0.350,0.360,0.370,
     *          0.380,0.390,0.400/
      DATA AKP1/7.50,7.25,7.05,6.85,6.70,6.55,6.40,6.25,6.10,
     *           5.95,5.80,5.70,5.60,5.49,5.42,5.34,5.27,5.20,
     *           5.13,5.06,5.00,4.88,4.76,4.66,4.57,4.50,4.42,
     *           4.34,4.28,4.18,4.10,4.03,3.97,3.91,3.85,3.80,
     *           3.75,3.70,3.65,3.60,3.55,3.50,3.45,3.40,3.35,
     *           3.30,3.26,3.23,3.20,3.17,3.15/
      CALL SPLING(N1,FRU,AKP1,FRUR,RK1)
      RETURN
      END
C ----------------------------------------------------------
      SUBROUTINE TYDATA(SRR,SFR,HSRR)
C     THIS SUB. USED TO GET INTERPOLATED DATA FROM
C          BRETSCHNEIDER'S TYPHOON FORECASTING CHART.
      PARAMETER(NRR=10,NFR=9)
C     RR TO BE R/R
C     FR1 TO BE(FR)/UR
C     HRR1 TO BE HR/HR
      DIMENSION RR(NRR),HRR1(NRR,NFR),FR1(NFR),HRR2(NRR),HRR3(NFR)
      DATA RR/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
      DATA FR1/0.,0.02,0.04,0.06,0.1,0.16,0.2,0.3,0.5/
      DATA HRR1/1.00,1.05,1.01,1.05,0.90,0.84,0.79,0.75,0.71,0.67
     1          ,1.00,1.03,0.98,0.90,0.83,0.76,0.69,0.63,0.58,0.54
     2          ,1.00,1.01,0.94,0.83,0.74,0.65,0.57,0.50,0.44,0.39
     3          ,1.00,1.00,0.89,0.78,0.67,0.57,0.47,0.40,0.33,0.28
     4          ,1.00,0.95,0.81,0.66,0.53,0.42,0.32,0.25,0.19,0.15
     5          ,1.00,0.91,0.74,0.55,0.41,0.29,0.21,0.14,0.10,0.07
     6          ,1.00,0.87,0.66,0.48,0.35,0.24,0.15,0.10,0.06,0.04
     7          ,1.00,0.83,0.57,0.35,0.22,0.13,0.08,0.04,0.03,0.02
     8          ,1.00,0.70,0.40,0.23,0.13,0.07,0.04,0.02,0.01,0.01/
      DO 144 I1=1,NFR
      DO 113 I2=1,NRR
      HRR2(I2)=HRR1(I2,I1)
113   CONTINUE
      CALL SPLING(NRR,RR,HRR2,SRR,HRR3(I1))
144   CONTINUE
      CALL SPLING(NFR,FR1,HRR3,SFR,HSRR)
      RETURN
      END
C-----------------------------------------------------------
      SUBROUTINE HT1(TANG,TMANG,VF,URS,RF,RMAX,UR,DP,DO,
     1               FRUR,SRR,HRM,HSRM)
```

```
C       WRITE(*,*) 'TANG=',TANG
        TANG=TANG+115
C       WRITE(*,*) 'TANG=',TANG
        TANG=ABS(TANG-TMANG)
C       WRITE(*,*) 'TANG=',TANG
        TANG=0.01745*TANG
        DU=0.5*VF*COS(TANG)
C       WRITE(*,*) 'CU=',DU
        URSM=URS+DU
C       WRITE(*,*) 'URSM=',URSM
        FRUR=RF*RMAX/UR
C       WRITE(*,*) 'FRUR=',FRUR
        CALL KPRAN(FRUR,RK1)
C       WRITE(*,*) 'RK1=',RK1
C       HR(FT)
        HR=RK1*(RMAX*DP)**0.5
C       WRITE(*,*) 'HR=',HR
C       WRITE(*,*) 'DD=',DD
        SRR=DD*0.53996/RMAX
C       WRITE(*,*) 'SRR=',SRR
        CALL TYDATA(SRR,FRUR,HSRR)
C       WRITE(*,*) 'HSRR=',HSRR
        HSR=HSRR*HR
C       WRITE(*,*) 'HSR=',HSR
        AB1=(URSM/URS)**2
C       HRM: (FT).
        HRM=HR*AB1
C       HSRM: (FT).
        HSRM=HSR*(URSM/URS)**2
C       WRITE(*,*) 'HSRM=',HSRM
        RETURN
        END
C----------------------------------------------------------------
        SUBROUTINE PERIOD(FRUR,SRR,UR,DU,HSRM,TSRM)
        AB1=0.5*FRUR*SRR
C       WRITE(*,*) 'AB1=',AB1
        AB2=(1.+FRUR)/SRR*EXP(1.-1./SRR)
C       WRITE(*,*) 'AB2=',AB2
        USR=UR*(-AB1+(AB2+AB1**2)**0.5)
C       WRITE(*,*) 'USR=',USR
        USRSM=0.865*USR+DU
C       WRITE(*,*) 'USRSM=',USRSM
        AB1=1.+40.*HSRM/(USRSM**2)
C       WRITE(*,*) 'AB1=',AB1
        AB2=1.-40.*HSRM/(USRSM**2)
C       WRITE(*,*) 'AB2=',AB2
        IF(AB1/AB2 .LE. 0.) THEN
          TSRM=0.
          GO TO 111
        END IF
        AB3=ALOG((AB1/AB2)**0.5)
C       WRITE(*,*) 'AB3=',AB3
        FO1=USRSM*0.4*TANH(AB3**0.6)
C       WRITE(*,*) 'FO1=',FO1
        TSRM=(0.8)**0.25*FO1
C       WRITE(*,*) 'TSRM=',TSRM
111     RETURN
        END
```

```
C-------------------------------------------------------------
      SUBROUTINE SPLING(NP,X,Y,XX,YY)
C ***********************************************************
C     THIS PROGRAM IS USED TO INTERPOLATE A CURVE BY
C         GLOBAL SPLINE CURVE.
C     NP: KNOWN POINT NUMBERS
C     X : X-COORDINATE OF NP POINTS
C     Y : Y-COORDINATE OF NP POINTS
C     XX: X-COORDINATE TO INTERPOLATE
C     YY: Y-COORDINATE CORRESPONDING TO XX
C ***********************************************************
      DIMENSION X(1),Y(1),A(50),B(50),D(50),H(50),
     1 BTA(50),GMA(50),FI(50),AB(3,50)
C     CAL EACH SEGMENT X COORDINATE DIFFERENCE.
      DO 12 I=1,NP-1
              H(I)=X(I+1)-X(I)
 12   CONTINUE
C     SOLVE SPLINE SIMULTANEOUS EQ.
      DO 13 I=2,NP-1
              A(I)=H(I-1)/H(I)
              B(I)=2.*(1+H(I-1)/H(I))
              ABS=(Y(I+1)-Y(I))/H(I)
              CR=(Y(I)-Y(I-1))/H(I-1)
              D(I)=(6./H(I))*(ABS-CR)
 13   CONTINUE
      BTA(2)=B(2)
      DO 14 IJ=3,NP-1
              BTA(IJ)=B(IJ)-A(IJ)/BTA(IJ-1)
              GMA(2)=D(2)/B(2)
              GMA(IJ)=(D(IJ)-A(IJ)*GMA(IJ-1))/BTA(IJ)
 14   CONTINUE
      FI(NP-1)=GMA(NP-1)
      FI(1)=0.
      FI(NP)=0.
      DO 15 IL=NP-2,2,-1
              FI(IL)=GMA(IL)-FI(IL+1)/BTA(IL)
 15   CONTINUE
      DO 17 I=1,NP-1
              IF(XX .LT. X(1)) GO TO 32
              IF(XX .GE. X(I) .AND. XX .LE. X(I+1)) GO TO 32
              IF(XX .GT. X(NP)) GO TO 50
 17   CONTINUE
      GO TO 32
 50   I=NP-1
 32           PP=FI(I)*(X(I+1)-XX)**3/(6*H(I))
              QQ=FI(I+1)*(XX-X(I))**3/(6*H(I))
              RR=Y(I+1)/H(I)-H(I)*FI(I+1)/6.
              SS=RR*(XX-X(I))
              TT=Y(I)/H(I)-H(I)*FI(I)/6.
              UU=TT*(X(I+1)-XX)
              YY=PP+QQ+SS+UU
      RETURN
      END
```

```
C       PROGRAM TSWELL.FOR (ONLY CONSIDER SWELL OF TYPHOON).
C       NG1MAX: ALLOWABLE MAX. GRID NO OF WIND FIELD.
C       NG2MAX: ALLOWABLE MAX. GRID NO OF WAVE FIELD.
C       NPHOON: ALLOWABLE MAX. NO     OF TYPHOON.
        PARAMETER (NG1MAX=500,NG2MAX=200,NPHOON=4)
        REAL LON1,LAT1
        REAL LON2(NG2MAX),LAT2(NG2MAX),LON22,LAT22
        INTEGER TYY,TMM,TDD,THR,CYY,CMM,CDD,CHR,TD
        DIMENSION AREA(34)
C       AREA: UNIT(KM**2)
        DATA AREA/9*0.,12141.610,12100.988,12056.530,12008.190,
     *       11954.620,11897.050,11839.210,11778.530,11711.180,
     *       11639.610,11566.310,11489.960,11409.170,11323.810,
     *       11236.520,11145.880,11051.750,10954.060,10852.820,
     *       10746.410,10638.940,10530.360,10416.390,10299.700,
     *       10177.280/
        OPEN(UNIT=1,FILE='WAVEGRD.DAT',STATUS='OLD')
        OPEN(UNIT=2,FILE='TPHOON1.DAT',STATUS='OLD')
        OPEN(UNIT=3,FILE='TPHOON2.DAT',STATUS='OLD')
        OPEN(UNIT=4,FILE='TPHOON3.DAT',STATUS='OLD')
        OPEN(UNIT=5,FILE='TPHOON4.DAT',STATUS='OLD')
        OPEN(UNIT=6,FILE='TSWELL.OUT',STATUS='NEW')
        OPEN(UNIT=10,FILE='CASTDATE.DAT'   ,STATUS='OLD')
        OPEN(UNIT=11,FILE='WINDGRD.DAT',STATUS='OLD')

        NG1=1
        REWIND 11
        READ(11,*)
 33     READ(11,*,END=34) I1,LON1,LAT1
        NG1=NG1+1
        GO TO 33
 34     NG1=NG1-1
        REWIND 11

        NG2=1
        REWIND 1
        READ(1,*)
 36     READ(1,*,END=37) I2,LON2(I2),LAT2(I2)
        NG2=NG2+1
        GO TO 36
 37     NG2=NG2-1
        REWIND 1

C       NDATE: TIME NO FOR FORECASTING WAVE.
        READ(10,*)
        NDATE=1
 43     READ(10,*,END=44) CYY,CMM,CDD,CHR
        NDATE=NDATE+1
        GO TO 43
 44     NDATE=NDATE-1
        REWIND 10

        READ(10,*)
        READ(1,*)
        XA=100.
        YA=5.
        SHH=0.
        STT=0.
```

```
      SUBA=0.
      SUBA1=0.
      LON22=121.
      LAT22=23.
      DO 898 JJ=1,NDATE
      READ(10,*) CYY,CMM,CDD,CHR
C     WRITE(6,*)
C     WRITE(6,123) JJ
      WRITE(6,132)
      WRITE(6,134) CYY,CMM,CDD,CHR
      WRITE(6,136)
      WRITE(*,*)
      WRITE(*,*)'-----------------------------------------------------'
      WRITE(*,*) 'FORECAST WAVE NO=',JJ
      WRITE(*,132)
      WRITE(*,134) CYY,CMM,CDD,CHR
      WRITE(*,*)
      WRITE(*,136)
C 123 FORMAT('1','FORECAST WAVE NO =',I2)
  132 FORMAT(1X,' YY',2X,'MM',1X,'DD',1X,'HR')
  134 FORMAT(1X,I4,3I3)
  136 FORMAT(3X,'PT.',5X,'LON',8X,'LAT',7X,'H13(CM)',
     1       4X,'T13(S)')
      DO 120 J=1,NG2
C      WRITE(*,*) 'NG2= ',J
       IF(LON2(J).EQ.LON22 .AND. LAT2(J).EQ.LAT22) THEN
         H13=0.
         T13=0.
         GO TO 111
       END IF
       CALL LONLTD(XA,YA,LON22,YA,CLON22)
       CALL LONLTD(XA,YA,XA,LAT22,CLAT22)
C         CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C         (LON.LAT.) OF CARTESIAN COORDINATE ORIGIN (XA,YA) TO BE (100,5).
C         CCX2: CARTESIAN X-COORDINATE OF WIND GRID POINT.
C         CCY2: CARTESIAN Y-COORDINATE OF WIND GRID POINT.
          CALL LONLTD(XA,YA,LON2(J),YA,CCX2)
          CALL LONLTD(XA,YA,XA,LAT2(J),CCY2)
       CALL SHELT(CLON22,CLAT22,CCX2,CCY2,NCODE,MAXITR)
      IF(NCODE .EQ. 0) THEN
        H13=0.
        T13=0.
        GO TO 111
      END IF
      DO 200 I1=1,NPHOON
C      WRITE(*,*) 'NPHOON= ',I1
      IF(I1 .EQ. 1) READ(2,*,END=200)
      IF(I1 .EC. 2) READ(3,*,END=200)
      IF(I1 .EQ. 3) READ(4,*,END=200)
      IF(I1 .EQ. 4) READ(5,*,END=200)
C       TMANG:THE DIRECTION(DEGREE,WITH+X AXIS)THAT TYPHOON MOVES.
  220     IF(I1.EQ.1)THEN
          READ(2,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                     R10,R7,TMANG
        ELSE IF(I1.EQ.2) THEN
          READ(3,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                     R10,R7,TMANG
        ELSE IF(I1.EQ.3) THEN
```

```
              READ(4,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,TMANG
            ELSE IF(I1.EQ.4) THEN
              READ(5,*,END=200)TYY,TMM,TDD,THR,TLON,TLAT,PO,VF,
     1                         R10,R7,TMANG
            END IF
C            WRITE(*,*) 'TYY',TYY,'TMM=',TMM,'TDD=',TDD,'THR=',THR
C            WRITE(*,*) 'TLON=',TLON,'TLAT=',TLAT
C            WRITE(*,*) 'PC=',PO,'VF=',VF
C            WRITE(*,*) 'R10=',R10,'R7=',R7,'TMANG=',TMANG
            CALL LONLTC(TLCN,TLAT,LON2(J),LAT2(J),DD)
C            WRITE(*,*) 'DD,R7=',DD,R7
            IF(DD.GT.R7) THEN
            DP=29.92-0.02953*PO
C            WRITE(*,*) 'DP=',DP
C            WRITE(*,*) 'TLAT=',TLAT
            CALL FK(TLAT,RF,RK)
C            WRITE(*,*) 'RF,RK=',RF,RK
C           RMAX (N.MILE)
C           WAVE HEIGHT: (FT)
C           WAVE PERIOC: (S)
            RMAX=R7/10.*0.53996
C            WRITE(*,*) 'RMAX=',RMAX
            UR=RK*(DP**0.5)-0.5*RF*RMAX
C            WRITE(*,*) 'UR=',UR
            URS=0.865*UR
C            WRITE(*,*) 'URS=',URS
            CALL HT2(RF,RMAX,UR,DP,
     1                FRUR,HRM)
             WRITE(*,*) 'HRM=',HRM
              CALL PERDD2(URS,HRM,TRM)
C               WRITE(*,*) 'TRM=',TRM
              CALL TIMCUR(TYY,TMM,TDD,THR,CYY,CMM,CDD,CHR,TD)
C             WRITE(*,*) 'TYY,TMM,TDD,THR=',TYY,TMM,TDD,THR
C             WRITE(*,*) 'CYY,CMM,CDD,CHR=',CYY,CMM,CDD,CHR
C             WRITE(*,*) 'TD=',TD
C               WRITE(*,*) 'RMAX,URS=',RMAX,URS
              AB1=DD*TRM/(RMAX*URS)
              C1=0.9063+0.1037*AB1-0.00295*(AB1**2)
              T13=C1*TRM
C             VEL: SWELL VELOCITY (KM/HR).
              VEL=1.56*T13*3600/1000
              DIST1=VEL*TD
C               WRITE(*,*) 'DIST1-DD (-):NOT REACH ',DIST1-DD
C               WRITE(*,*) '???? MODIFY ????'
C               IF(ABS(DIST1-DD) .GT. 50) THEN
C                 H13=0.
C                 T13=0.
C                 GO TO 220
C               END IF
C             HRM:(FT)
C             H13:(M)
C               WRITE(*,*) 'DD=',DD
              H13=0.11*HRM*RMAX/(DD**0.5)
C               WRITE(*,*) 'VEL=',VEL
              TD1=DD/VEL
C               WRITE(*,*)'TYPHOON DATA TIME INTERVAL 6HRS'
C               WRITE(*,*) 'TD1=',TD1
```

```
      H13=H13*((6./TD1)**0.5)
      REWIND 11
      READ(11,*)
      DO 135 JS=1,NG1
      READ(11,*) NPT,LON1,LAT1
      CALL LONLTD(TLON,TLAT,LON1,LAT1,DD1)
C      WRITE(*,*) 'NPT,DD1,R7=',NPT,DD1,R7
      IF (DD1 .GT .R7) GO TO 135
C      WRITE(*,*) 'RMAX=',RMAX
      SRR=DD1/RMAX
      CALL GSPEED(FRUR,SRR,UR,USRSM)
C     CHANGE (LONGITUDE,LATITUDE) INTO CARTESIAN COORDINATE.
C     (LON.LAT.) OF CARTESIAN COORDINATE ORIGIN (XA,YA) TO BE (100,5).
C     CCX2: CARTESIAN X-COORDINATE OF WAVE GRID POINT.
C     CCY2: CARTESIAN Y-COORDINATE OF WAVE GRID POINT.
C     CTLON: CARTESIAN X-COORDINATE OF TYPHOON CENTER.
C     CTLAT: CARTESIAN Y-COORDINATE OF TYPHOON CENTER.
      CALL LONLTD(XA,YA,TLON,YA,CTLON)
      CALL LONLTD(XA,YA,XA,TLAT,CTLAT)
      CALL ANGLE(CCX1,CCY1,CTLON,CTLAT,TANG2)
      CALL ANGLE(CCX2,CCY2,CTLON,CTLAT,TANG1)
      TANG2=TANG2+115
      TANG2=ABS(TANG2-TANG1)
      TANG2=0.01745*TANG2
      LATJ=INT(TLAT)
      AB1=(USRSM*COS(TANG2))**2
      SUBA=SUBA+AB1*AREA(LATJ)
      CALL LONLTD(XA,YA,LON1,YA,CCX1)
      CALL LONLTD(XA,YA,XA,LAT1,CCY1)
      CALL SHELT(CTLON,CTLAT,CCX1,CCY1,NCODE,MAXITR)
      IF (NCODE.GT.0) GO TO 135
      SUBA1=SUBA1+AB1*AREA(LATJ)
135   CONTINUE
C      WRITE(*,*) 'SUBA=',SUBA
      IF(SUBA .EQ. 0.) THEN
        H13=0.
      ELSE
        CE=(SUBA1/SUBA)**0.5
        H13=H13*CE
      END IF
    ELSE
      H13=0.
      T13=0.
    END IF
    SHH=SHH+H13**2
    STT=STT+T13*(H13**2)
    SUBA1=0
    SUBA=0
C    WRITE(*,*) 'SHH=',SHH
C    WRITE(*,*) 'STT=',STT
    GO TO 220
200  CONTINUE
     IF(SHH .EQ. 0.) THEN
     T13=0.
     H13=0.
     GO TO 111
     END IF
C    WRITE(*,*) 'AFTER 200,SHH=',SHH
```

```
C        WRITE(*,*) 'AFTER 200,STT=',STT
         T13=STT/SHH
         H13=SHH**0.5
 111     WRITE(6,138) J,LON2(J),LAT2(J),30.48*H13,T13
         WRITE(*,138) J,LON2(J),LAT2(J),30.48*H13,T13
 138     FORMAT(1X,I4,4(1X,F10.3))
         SHH=0.
         STT=0.
         REWIND 2
         REWIND 3
         REWIND 4
         REWIND 5
 120       CONTINUE
 888     CONTINUE
 310     FORMAT(1X,I3,1X,I4,1X,I2,1X,I2,1X,I2,4(1X,F10.3))
         STOP
         END
C---------------------------------------------------------------------
         SUBROUTINE FK(FI,RF,RK)
C        FI:  INPUT LATITUDE OF TYPHOON CENTER.
C        FFI:  LATITUDE ARRAY OF TYPHOON CENTER.
C        FIF: F IN CHART.
C        FIK: K IN CHART.
         PARAMETER (N1=9)
         DIMENSION FFI(N1),FIF(N1),FIK(N1)
         DATA FFI/20.,22.5,25.,27.5,30.,32.5,35.,37.5,40.0/
         DATA FIF/0.18,0.20,0.22,0.24,0.26,0.28,0.30,0.32,0.34/
         DATA FIK/67.,67.,67.,66.,66.,66.,66.,65.,64./
         CALL SPLING(N1,FFI,FIF,FI,RF)
         CALL SPLING(N1,FFI,FIK,FI,RK)
         RETURN
         END
C---------------------------------------------------------------------
         SUBROUTINE KPRAN(FRUR,RK1)
C        FRUR: FR/UR IN CHART
         PARAMETER (N1=51)
         DIMENSION FRU(N1),AKP1(N1)
         DATA FRU/0.000,0.005,0.010,0.015,0.020,0.025,0.030,0.035,
     *            0.040,0.045,0.050,0.055,0.060,0.065,0.070,0.075,
     *            0.080,0.085,0.090,0.095,0.100,0.110,0.120,0.130,
     *            0.140,0.150,0.160,0.170,0.180,0.190,0.200,0.210,
     *            0.220,0.230,0.240,0.250,0.260,0.270,0.280,0.290,
     *            0.300,0.310,0.320,0.330,0.340,0.350,0.360,0.370,
     *            0.380,0.390,0.400/
         DATA AKP1/7.50,7.25,7.05,6.85,6.70,6.55,6.40,6.25,6.10,
     *             5.95,5.80,5.70,5.60,5.49,5.42,5.34,5.27,5.20,
     *             5.13,5.06,5.00,4.88,4.76,4.66,4.57,4.50,4.42,
     *             4.34,4.28,4.18,4.10,4.03,3.97,3.91,3.85,3.80,
     *             3.75,3.70,3.65,3.60,3.55,3.50,3.45,3.40,3.35,
     *             3.30,3.26,3.23,3.20,3.17,3.15/
         CALL SPLING(N1,FRU,AKP1,FRUR,RK1)
         RETURN
         END
C ---------------------------------------------------------------------
         SUBROUTINE TYDATA(SRR,SFR,HSRR)
C        THIS SUB. USED TO GET INTERPOLATED DATA FROM
C             BRETSCHNEIDER'S TYPHOON FORECASTING CHART.
         PARAMETER(NRR=10,NFR=9)
```

```
C        RR TO BE R/R
C        FR1 TO BE(FR)/UR
C        HRR1 TO BE HR/HR
         DIMENSION RR(NRR),HRR1(NRR,NFR),FR1(NFR),HRR2(NRR),HRR3(NFR)
         DATA RR/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
         DATA FR1/0.,0.02,0.04,0.06,0.1,0.16,0.2,0.3,0.5/
         DATA HRR1/1.00,1.05,1.01,1.05,0.90,0.84,0.79,0.75,0.71,0.67
     1            ,1.00,1.03,0.98,0.90,0.83,0.76,0.69,0.63,0.58,0.54
     2            ,1.00,1.01,0.94,0.83,0.74,0.65,0.57,0.50,0.44,0.39
     3            ,1.00,1.00,0.89,0.78,0.67,0.57,0.47,0.40,0.33,0.28
     4            ,1.00,0.95,0.81,0.66,0.53,0.42,0.32,0.25,0.19,0.15
     5            ,1.00,0.91,0.74,0.55,0.41,0.29,0.21,0.14,0.10,0.07
     6            ,1.00,0.87,0.66,0.48,0.35,0.24,0.15,0.10,0.06,0.04
     7            ,1.00,0.83,0.57,0.35,0.22,0.13,0.08,0.04,0.03,0.02
     8            ,1.00,0.70,0.40,0.23,0.13,0.07,0.04,0.02,0.01,0.01/
         DO 144 I1=1,NFR
         DO 113 I2=1,NRR
         HRR2(I2)=HRR1(I2,I1)
 113     CONTINUE
         CALL SPLING(NRR,RR,HRR2,SRR,HRR3(I1))
 144     CONTINUE
         CALL SPLING(NFR,FR1,HRR3,SFR,HSRR)
         RETURN
         END
C-------------------------------------------------------------------
         SUBROUTINE HTZ(RF,RMAX,UR,DP,
     1                    FRUR,HRM)
         FRUR=RF*RMAX/UR
C         WRITE(*,*) 'FRUR=',FRUR
         CALL KPRAN(FRUR,RK1)
C         WRITE(*,*) 'RK1=',RK1
C        HR(FT)
         HR=RK1*(RMAX*DP)**0.5
C         WRITE(*,*) 'HR=',HR
C        HRM: (FT).
         HRM=HR
         RETURN
         END
C-------------------------------------------------------------------
         SUBROUTINE PEROD2(URS,HRM,TRM)
C        SRR=1
         USRSM=URS
C         WRITE(*,*) 'USRSM=',USRSM
         AB1=1.+40.*HRM/(USRSM**2)
C         WRITE(*,*) 'AB1=',AB1
         AB2=1.-40.*HRM/(USRSM**2)
C         WRITE(*,*) 'AB2=',AB2
         IF(AB1/AB2 .LE. 0.) THEN
           TRM=0.
           GO TO 111
         END IF
         AB3=ALOG((AB1/AB2)**0.5)
C         WRITE(*,*) 'AB3=',AB3
         FO1=USRSM*0.4*TANH(AB3**0.6)
C         WRITE(*,*) 'FO1=',FO1
         TRM=(0.8)**0.25*FO1
C         WRITE(*,*) 'TRM=',TRM
 111     RETURN
```

```
      END
C------------------------------------------------------------------
      SUBROUTINE GSPEED(FRUR,SRR,UR,USRSM)
      AB1=0.5*FRUR*SRR
      AB2=(1.+FRUR)/SRR*EXP(1.-1./SRR)
      USR=UR*(-AB1+(AB2+AB1**2)**0.5)
      USRSM=0.865*USR
      RETURN
      END
C------------------------------------------------------------------
      SUBROUTINE SPLING(NP,X,Y,XX,YY)
C ****************************************************
C     THIS PROGRAM IS USED TO INTERPOLATE A CURVE BY
C          GLOBAL SPLINE CURVE.
C     NP: KNOWN POINT NUMBERS
C     X : X-COORDINATE OF NP POINTS
C     Y : Y-COORDINATE OF NP POINTS
C     XX: X-COORDINATE TO INTERPOLATE
C     YY: Y-COORDINATE CORRESPONDING TO XX
C ****************************************************
      DIMENSION X(1),Y(1),A(50),B(50),C(50),H(50),
     1 BTA(50),GMA(50),FI(50),AB(3,50)
C     CAL EACH SEGMENT X COORDINATE DIFFERENCE.
      DO 12 I=1,NP-1
              H(I)=X(I+1)-X(I)
 12   CONTINUE
C     SOLVE SPLINE SIMULTANEOUS EQ.
      DO 13 I=2,NP-1
              A(I)=H(I-1)/H(I)
              B(I)=2.*(1+H(I-1)/H(I))
              ABS=(Y(I+1)-Y(I))/H(I)
              CR=(Y(I)-Y(I-1))/H(I-1)
              D(I)=(6./H(I))*(ABS-CR)
 13   CONTINUE
      BTA(2)=B(2)
      DO 14 IJ=3,NP-1
              BTA(IJ)=B(IJ)-A(IJ)/BTA(IJ-1)
              GMA(2)=D(2)/B(2)
              GMA(IJ)=(D(IJ)-A(IJ)*GMA(IJ-1))/BTA(IJ)
 14   CONTINUE
      FI(NP-1)=GMA(NP-1)
      FI(1)=0.
      FI(NP)=0.
      DO 15 IL=NP-2,2,-1
              FI(IL)=GMA(IL)-FI(IL+1)/BTA(IL)
 15   CONTINUE
      DO 17 I=1,NP-1
              IF(XX .LT. X(1)) GO TO 32
              IF(XX .GE. X(I) .AND. XX .LE. X(I+1)) GO TO 32
              IF(XX .GT. X(NP)) GO TO 50
 17   CONTINUE
      GO TO 32
 50   I=NP-1
 32           PP=FI(I)*(X(I+1)-XX)**3/(6*H(I))
              QQ=FI(I+1)*(XX-X(I))**3/(6*H(I))
              RR=Y(I+1)/H(I)-H(I)*FI(I+1)/6.
              SS=RR*(XX-X(I))
              TT=Y(I)/H(I)-H(I)*FI(I)/6.
```

```
              UU=TT*(X(I+1)-XX)
              YY=PP+QQ+SS+UU
        RETURN
        END
C-----------------------------------------------------------------------
```

```
C         SUMCWB.FOR
C         THIS PROG. USED TO INTEGRATE MONSOON, TYPHOON WIND WAVE, SWELL
          INTEGER CYY,CMM,CDD,CHR
          CHARACTER*70 REC1,REC2,REC3
          REAL LON2,LAT2
          OPEN(UNIT=1,FILE='MONSOON.OUT',STATUS='OLD')
          OPEN(UNIT=2,FILE='TWINDW.OUT',STATUS='OLD')
          OPEN(UNIT=3,FILE='TSWELL.OUT',STATUS='OLD')
          OPEN(UNIT=4,FILE='CASTDATE.DAT',STATUS='OLD')
          OPEN(UNIT=5,FILE='SUMCWB.OUT',STATUS='NEW')
          OPEN(UNIT=6,FILE='WAVEGRD.DAT',STATUS='OLD')
          READ(4,*)
          NDATE=1
   33     READ(4,*,END=34) CYY,CMM,CDD,CHR
          NDATE=NDATE+1
          GO TO 33
   34     NDATE=NDATE-1
          READ(6,*)
          NG2=1
   36     READ(6,*,END=38) NT,LON2,LAT2
          NG2=NG2+1
          GO TO 36
   38     NG2=NG2-1
          DO 50 JJ=1,NDATE

            WRITE(5,123) JJ
  123       FORMAT('1','FORECAST WAVE NO=',I2)
            READ(1,54) REC1
            WRITE(5,54) REC1

            READ(1,54) REC2
            WRITE(5,54) REC2

            READ(1,54) REC3
            WRITE(5,54) REC3

            READ(2,*)
            READ(2,*)
            READ(2,*)

            READ(3,*)
            READ(3,*)
            READ(3,*)

            WRITE(*,*) ' FORECAST WAVE NO=',JJ
            WRITE(*,*) REC1
            WRITE(*,*) REC2
            WRITE(*,*) REC3
            DO 60 J=1,NG2
C             WRITE(*,*) 'J=',J
              READ(1,*) NPT,LON2,LAT2,H1,T1
              READ(2,*) NPT,LON2,LAT2,H2,T2
              READ(3,*) NPT,LON2,LAT2,H3,T3
              SH2=H1**2+H2**2+H3**2
              H13=SH2**0.5
              T13=(T1*H1**2+T2*H2**2+T3*H3**2)/SH2
              WRITE(5,70) J,LON2,LAT2,H13,T13
              WRITE(*,70)  J,LON2,LAT2,H13,T13
```

```
70          FORMAT(1X,I4,4(1X,F10.3))
60        CONTINUE
50      CONTINUE
54      FORMAT(A70)
        STOP
        END
```

```
C-----------------------------------------------------------------------
        SUBROUTINE SHELT(CXM,CYM,CX2,CY2,NCODE,MAXITR)
C
C       (CXM,CYM): CARTESIAN COORDINATE OF MEASURING STATION.
C       (CX2,CY2): CARTESIAN COORDINATE OF WIND GRID POINT.
C       NCODE=1: THE MEASURE STATION IS SHELTERED.
C       NCODE=0: THE MEASURE STATION IS NOT SHELTERED.
C       MAXITR : MAX. ITERATION NUMBER FOR ALL SHELTERED PROCESS.
C       EPS: ALLOWABLE ERROR MARGIN IN ITERATION.
C       NITER: TOTAL ITERATION TIMES.
C
        DATA EPS/1./,NITER/10/
        MAXITR=0
        IF(CYM .EQ. CY2) THEN
          CY2=CY2+0.125
          NCY2=1
        END IF
        IF(CXM .EQ. CX2) THEN
          CX2=CX2+0.125
          NCX2=1
        END IF
C       RXMIN: MIN. X VALUE OF SEGMENT OF MEASURING STATION TO WIND GRID POINT.
C       RYMIN: .... Y .............................................................
C       RXMAX: MAX. X .............................................................
C       RYMAX: .... Y .............................................................
        RXMIN=AMIN1(CXM,CX2)
        RXMAX=AMAX1(CXM,CX2)
        RYMIN=AMIN1(CYM,CY2)
        RYMAX=AMAX1(CYM,CY2)
        NCODE=0
C........
        CALL TSLT1(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL MSLT2(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL HSLT3(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL KSLT4(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
C        CALL JSLT5(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
C     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL JSLT6(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL JSLT7(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
        CALL PSLT8(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
C        CALL PSLT9(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
C     *             RYMIN,RYMAX,NCODE,MAXITR)
C        CALL PSLT10(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
C     *             RYMIN,RYMAX,NCODE,MAXITR)
C        CALL PSLT11(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
C     *             RYMIN,RYMAX,NCODE,MAXITR)
C        CALL PSLT12(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
C     *             RYMIN,RYMAX,NCODE,MAXITR)
C........
        IF(NCY2 .EQ. 1) THEN
          CY2=CY2-0.125
```

```
        END IF
        IF(NCX2 .EQ. 1) THEN
          CX2=CX2-0.125
        END IF
        NCX2=0
        NCY2=0
        RETURN
        END
C-----------------------------------------------------------------------
        SUBROUTINE TSLT1(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *                RYMIN,RYMAX,NCODE,MAXITR)
C       THIS SUB. CHECK IF THE WIND GRID POINT IS SHELTERED BY TAIWAN.
C       NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C       NLAND=1: REPRESENT TAIWAN.
C........
        PARAMETER(NC=12)
        DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
        NLAND=1
C       THE FOLLOWING DATA DECLARATION ALL TO BE CARTESIAN COORDINATION.
C       THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
C       UNIT OF COORDINATE: KM
        DATA XMIN/2280.267,2247.062,2235.992,2224.925,2224.925,
     1            2335.608,2390.949,2413.085,2390.949,2357.744,
     2            2324.539,2302.403/
        DATA XMAX/2302.403,2280.267,2247.062,2235.992,2335.608,
     1            2390.949,2413.085,2424.154,2424.154,2390.949,
     2            2357.744,2324.539/
        DATA YMIN/1889.040,1933.488,1944.600,2011.272,2066.832,
     1            2222.399,2233.511,2177.952,2111.280,2000.160,
     2            1944.600,1889.040/
        DATA YMAX/1933.488,1944.600,2011.272,2066.832,2222.399,
     1            2255.737,2255.737,2233.511,2177.952,2111.280,
     2            2000.160,1944.600/
C........
        CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *             NLAND,NC,NCODE,MAXITR)
        RETURN
        END
        SUBROUTINE MSLT2(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *             RYMIN,RYMAX,NCODE,MAXITR)
C       THIS SUB. CHECK IF THE WIND GRID POINT IS SHELTERED BY MAINLAND.
C       NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C       NLAND=2: REPRESENT MAINLAND.
C........
        PARAMETER(NC=34)
        DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
        NLAND=2
C       THE FOLLOWING DATA DECLARATION ALL TO BE CARTESIAN COORDINATION.
C       THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
        DATA XMIN/730.60,918.78,708.46,664.18,619.90,619.90,
     *            719.52,999.27,1062.68,1062.68,1140.17,1140.17,
     *            1140.17,1273.00,1383.69,1450.11,1516.52,1605.07,
     *            2014.62,2081.03,2180.65,2180.65,2247.06,2335.61,
     *            2390.95,2402.02,2357.74,2258.13,2258.13,2346.68,
     *            2346.68,2346.68,2313.47,2125.31/
        DATA XMAX/1018.40,1018.40,918.78,708.46,664.18,719.52,
     *            999.27,1073.75,1073.75,1140.17,1162.31,1162.31,
```


1410

```
     *           1273.00,1383.69,1450.11,1516.52,1605.07,2014.62,
     *           2081.03,2191.72,2191.72,2247.06,2335.61,2390.95,
     *           2402.02,2435.22,2435.22,2357.74,2346.68,2424.15,
     *           2424.15,2414.09,2413.09,2313.47/
      DATA YMIN/600.04,755.62,1144.54,1422.34,1489.01,1555.68,
     *           1700.14,1844.59,1777.92,1711.25,1711.25,1722.36,
     *           1766.81,1833.48,1866.82,1922.38,1955.71,1966.82,
     *           2166.84,2222.40,2377.97,2411.30,2444.64,2577.98,
     *           2600.21,2689.11,2778.00,2811.34,2811.34,2844.67,
     *           2878.01,2955.79,2955.79,3066.91/
      DATA YMAX/755.62,1144.54,1422.34,1489.01,1555.68,1700.14,
     *           1866.82,1866.82,1844.59,1777.92,1722.36,1766.81,
     *           1833.48,1866.82,1922.38,1955.71,1966.82,2166.84,
     *           2222.40,2377.97,2411.30,2444.64,2577.98,2600.21,
     *           2689.11,2778.00,2811.34,2811.34,2844.67,2878.01,
     *           2966.91,2966.91,3066.91,3311.38/
C........
      CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *           NLAND,NC,NCODE,MAXITR)
      RETURN
      END
      SUBROUTINE HSLT3(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,NCODE,MAXITR)
C     THIS SUB. CHECK IF WIND GRID POINT IS SHELTERED BY HAILAND.
C     NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C     NLAND=3: REPRESENT HAILAND.
C........
      PARAMETER(NC=4)
      DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
      NLAND=3
C     THE FOLLOWING DATA DECLARATION ALL TC BE CARTESIAN COORDINATION.
C     THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
      DATA XMIN/1173.373,1029.474,963.057,963.057/
      DATA XMAX/1217.654,1173.373,1029.474,1217.654/
      DATA YMIN/1600.127,1477.896,1477.896,1589.016/
      DATA YMAX/1722.360,1600.127,1589.016,1722.360/
C........
      CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *           NLAND,NC,NCODE,MAXITR)
      RETURN
      END
      SUBROUTINE KSLT4(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,NCODE,MAXITR)
C     THIS SUB. CHECK IF WIND GRID POINT IS SHELTERED BY KOREA.
C     NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C     NLAND=4: REPRESENT KOREA.
C........
      PARAMETER(NC=2)
      DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
      NLAND=4
C     THE FOLLOWING DATA DECLARATION ALL TO BE CARTESIAN COORDINATION.
C     THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
      DATA XMIN/2911.136,2933.271/
      DATA XMAX/2933.271,3154.615/
      DATA YMIN/3255.816,3255.816/
      DATA YMAX/3311.376,3322.489/
```

```
C........
        CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *            RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *            NLAND,NC,NCODE,MAXITR)
        RETURN
        END
        SUBROUTINE JSLT6(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *            RYMIN,RYMAX,NCODE,MAXITR)
C       THIS SUB. CHECK IF WIND GRID POINT IS SHELTERED BY NINEZO.
C       NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C       NLAND=6: REPRESENT NINEZO.
C........
        PARAMETER(NC=10)
        DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
        NLAND=6
C       THE FOLLOWING DATA DECLARATION ALL TO BE CARTESIAN COORDINATION.
C       THE (LONGITUDE,LATITUDE) OF CRIGION TO BE (100,5).
        DATA XMIN/3431.284,3353.819,3265.284,3265.284,3342.751,3342.751
     *            ,3342.751,3398.084,3486.617,3508.749/
        DATA XMAX/3508.749,3431.284,3353.819,3342.751,3353.819,3353.819
     *            ,3398.084,3486.617,3530.881,3530.881/
        DATA YMIN/3133.585,3189.144,3144.696,3078.025,3078.025,3011.352
     *            ,2900.232,2900.232,2989.129,3089.137/
        DATA YMAX/3189.144,3200.256,3200.256,3144.696,3122.472,3122.472
     *            ,3011.352,2989.129,3089.137,3133.585/
C........
        CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *            RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *            NLAND,NC,NCODE,MAXITR)
        RETURN
        END
        SUBROUTINE JSLT7(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *            RYMIN,RYMAX,NCODE,MAXITR)
C       THIS SUB. CHECK IF WIND GRID POINT IS SHELTERED BY FOURGO.
C       NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C       NLAND=7: REPRESENT FOURGO.
C........
        PARAMETER(NC=7)
        DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
        NLAND=7
C       THE FOLLOWING DATA DECLARATION ALL TO BE CARTESIAN COORDINATION.
C       THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
        DATA XMIN/3763.269,3685.808,3630.478,3564.080,3564.080,3641.542
     *            ,3741.138/
        DATA XMAX/3829.664,3763.269,3685.808,3630.478,3641.542,3741.138
     *            ,3829.664/
        DATA YMIN/3200.256,3211.368,3211.368,3155.808,3078.025,3078.025
     *            ,3166.919/
        DATA YMAX/3255.816,3255.816,3222.480,3222.480,3155.808,3166.919
     *            ,3200.256/
C........
        CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *            RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *            NLAND,NC,NCODE,MAXITR)
        RETURN
        END
C---------------------------------------------------------------------
        SUBROUTINE PSLT8(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
```


1412

```
     *                RYMIN,RYMAX,NCODE,MAXITR)
C        THIS SUB. CHECK IF WIND GRID POINT IS SHELTERED BY LIUSON.
C        NC: CURVE NUMBERS FOR ONE LAND CONTOUR.
C        NLAND=8: REPRESENT LIUSON.
C........
         PARAMETER(NC=21)
         DIMENSION XMIN(NC),XMAX(NC),YMIN(NC),YMAX(NC)
         NLAND=8
C        THE FOLLOWING DATA DECLARATION ALL TC BE CARTESIAN COORDINATION.
C        THE (LONGITUDE,LATITUDE) OF ORIGION TO BE (100,5).
         DATA XMIN/2247.062,2235.992,2191.719,2191.719,2269.198,2269.198
     *           ,2269.198,2402.017,2490.562,2501.630,2590.175,2612.310
     *           ,2612.310,2490.562,2368.813,2368.813,2468.426,2446.290
     *           ,2446.290,2335.608,2247.062/
         DATA XMAX/2269.198,2269.198,2235.992,2269.198,2324.539,2324.539,
     *           2402.017,2490.562,2501.630,2590.175,2678.717,2678.717,
     *           2645.514,2645.514,2490.562,2468.426,2490.562,2490.562,
     *           2468.426,2468.426,2335.608/
         DATA YMIN/1355.663,1233.432,1233.432,1044.528,1044.528,966.742,
     *           966.742,900.071,900.071,888.960,877.848,877.848,
     *           955.630,966.742,1022.305,1144.535,1277.880,1333.441,
     *           1433.448,1500.120,1389.000/
         DATA YMAX/1389.000,1355.663,1255.656,1255.656,1055.641,1055.641,
     *           988.968,988.968,977.856,977.856,888.960,955.630,
     *           966.742,1022.305,1144.535,1277.880,1333.441,1433.448,
     *           1500.120,1500.120,1500.120/
C........
         CALL CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *           NLAND,NC,NCODE,MAXITR)
         RETURN
         END
C-----------------------------------------------------------------------
         SUBROUTINE CROSS(CXM,CYM,CX2,CY2,XA,YA,EPS,NITER,RXMIN,RXMAX,
     *           RYMIN,RYMAX,XMIN,XMAX,YMIN,YMAX,
     *           NLAND,NC,NCODE,MAXITR)
         DIMENSION XMIN(1),XMAX(1),YMIN(1),YMAX(1)
         DO 99 II=1,NC
            X=(XMIN(II)+XMAX(II))/2.
            DO 20 I=1,NITER
               XCLD=X
C...........
                 IF(NLAND .EQ. 1) X=TG1(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 2) X=MG2(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 3) X=HG3(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 4) X=KG4(X,CXM,CYM,CX2,CY2,CX,II)
C                 IF(NLAND .EQ. 5) X=JG5(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 6) X=JG6(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 7) X=JG7(X,CXM,CYM,CX2,CY2,CX,II)
                 IF(NLAND .EQ. 8) X=PG8(X,CXM,CYM,CX2,CY2,CX,II)
C                 IF(NLAND .EQ. 9) X=PG9(X,CXM,CYM,CX2,CY2,CX,II)
C                 IF(NLAND .EQ. 10) X=PG10(X,CXM,CYM,CX2,CY2,CX,II)
C                 IF(NLAND .EQ. 11) X=PG11(X,CXM,CYM,CX2,CY2,CX,II)
C                 IF(NLAND .EQ. 12) X=PG12(X,CXM,CYM,CX2,CY2,CX,II)
C...........
                 IF(ABS(X-XCLD).LE.EPS .AND. X.GE.XMIN(II) .AND.
     *              X.LE.XMAX(II) .AND. X.GE.RXMIN .AND. X.LE.RXMAX
     *              .AND. CX.GE.YMIN(II) .AND. CX.LE.YMAX(II) .AND.
```

```
              X.LE.XMAX(II) .AND. X.GE.XMIN(II) .AND.
              .AND. CX.GE.YMIN(II) .AND. CX.LE.YMAX(II) .AND.
```



```
     *                CX.GE.RYMIN .AND. CX.LE.RYMAX) THEN
                NCODE=NCODE+1
                IF(I.GE.MAXITR) MAXITR=I
C               WRITE(*,*)
C               WRITE(*,*) '   NLAND        = ',NLAND
C               WRITE(*,*) '   THE CURVE NO = ',II
C               WRITE (*,45) I
C  45           FORMAT(' CONVERGES IN',I4,' ITERATION/')
                GO TO 99
             END IF
   20     CONTINUE
   99   CONTINUE
        RETURN
        END
C-----------------------------------------------------------------------
C........
        FUNCTION TG1(X,CXM,CYM,CX2,CY2,CX,II)
C       CX: CURVE FITTING FUNCTION OF LAND.
C       PCX: THE FIRST ORDER DERIVATIVE OF FUNCTION CX.
        X22=X**2
        GO TO (5,10,15,20,25,30,35,40,45,50,55,60) ,II
 5           CX=6.50779E+03-2.00605*X
             PCX=-2.00605
             GO TO 2
 10           CX=2.70197E+03-3.37030E-01*X
            PCX=-3.37030E-01
             GO TO 2
 15           CX=1.54557E+04-6.01274E+00*X
            PCX=-6.01274E+00
             GO TO 2
 20           CX=1.34447E+04-5.11360E+00*X
            PCX=-5.11360E+00
             GO TO 2
 25           CX=-1.05982E+03+1.40529E+00*X
            PCX=1.40529E+00
             GO TO 2
 30           CX=8.14162E+02+6.02936E-01*X
            PCX=6.02936E-01
             GO TO 2
 35         CX=4.64754E+03-1.00038E+00*X
            PCX=-1.00038E+00
             GO TO 2
 40           CX=1.43185E+04-5.00814E+00*X
            PCX=-5.00814E+00
             GO TO 2
 45           CX=-2.69360E+03+2.00960E+00*X
            PCX=2.00960E+00
             GO TO 2
 50           CX=-5.87323E+03+3.33942E+00*X
            PCX=3.33942E+00
             GO TO 2
 55           CX=-1.94951E+03+1.67521E+00*X
            PCX=1.67521E+00
             GO TO 2
 60           CX=-3.89087E+03+2.51038E+00*X
            PCX=2.51038E+00
C........
 2          YX21=(CY2-CYM)/(CX2-CXM)
```

```
C        FX: THE ROOT OF EQUATION FX=0 REPRESENTS THE INTERSECTION POINT
C              BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
         FX=CX-YX21*(X-CXM)-CYM
C        PFX: THE FIRST ORDER DERIVATIVE OF FUNCTION FX.
         PFX=PCX-YX21
C........
         TG1=X-FX/PFX
C........
         RETURN
         END
C-----------------------------------------------------------------------
         FUNCTION MG2(X,CXM,CYM,CX2,CY2,CX,II)
C        CX: CURVE FITTING FUNCTION OF LAND.
C        PCX: THE FIRST ORDER DERIVATIVE OF FUNCTION CX.
         X22=X**2
         X33=X**3
         GO TO (5,10,15,20,25,30,35,40,45,50,55,60,65,70,75,80,85,
     1          90,95,100,105,110,115,120,125,130,135,140,145,150,
     2          155,160,165,170) ,II
5              CX=1.6930E+03-2.9405*X+1.9791E-03*X22
             PCX=-2.9405+3.9582E-03*X
             GO TO 2
10              CX=1.7272E+03+1.2087*X-2.0058E-03*X22
              PCX=1.2087-4.0116E-03*X
             GO TO 2
15              CX=2.3581E+03-1.3209*X
              PCX=-1.3209
             GO TO 2
20              CX=-1.917E+05+5.6574E+02*X-4.1390E-01*X22
             PCX=5.6574E+02-0.8278*X
             GO TO 2
25              CX=2.489E+03-1.5056*X
             PCX=-1.5056
             GO TO 2
30              CX=-1.0361E+04+3.4527E+01*X-2.469E-02*X22
             PCX=3.4527E+01-0.04938*X
             GO TO 2
35              CX=2.9264E+02+3.0136*X-1.444E-03*X22
             PCX=3.0136-2.888E-03*X
             GO TO 2
40              CX=-5.1761E+04+1.0429E+02*X-5.0664E-02*X22
             PCX=1.0429E+02-0.10133*X
             GO TO 2
45              CX=-4.6195E+03+6.0201*X
             PCX=6.0201
             GO TO 2
50              CX=4.781E+04-8.279E+01*X+3.7231E-02*X22
             PCX=-8.28779E+01+0.07446*X
             GC TO 2
55              CX=1.1389E+03+5.0201E-01*X
             PCX=5.0201E-01
             GO TO 2
60              CX=4.057E+03-2.0086*X
             PCX=-2.0086
             GO TO 2
65              CX=-4.0149E+03+9.305*X-3.7014E-03*X22
             PCX=9.305-7.4028E-03*X
             GO TO 2
```

```
70        CX=-5.545E+03+1.1457E+01*X-4.1994E-03*X22
        PCX=1.1457E+01-8.3988E-03*X
        GO TO 2
75        CX=-2.6099E+03+5.6595*X-1.7532E-03*X22
        PCX=5.6595-3.5064E-03*X
        GO TO 2
80        CX=-4.6768E+04+6.5347E+01*X-2.1914E-02*X22
        PCX=6.5347E+01-0.04383*X
        GO TO 2
85        CX=1.3355E+05-1.6895E+02*X+5.4198E-02*X22
        PCX=-1.6896E+02+0.1084*X
        GO TO 2
90        CX=6.5286E+03-5.4731*X+1.6393E-03*X22
        PCX=-5.4731+3.2786E-03*X
        GO TO 2
95        CX=8.122E+04-7.8018E+01*X+1.9248E-02*X22
        PCX=-7.8018E+01+0.0385*X
        GO TO 2
100        CX=1.1250E+04-9.8082*X+2.6257E-03*X22
        PCX=-9.8082+5.2514E-03*X
        GO TO 2
105        CX=8.9047E+03-2.9778*X
        PCX=-2.9778
        GO TO 2
110        CX=-3.058E+05+2.7798E+02*X-6.2667E-02*X22
        PCX=2.7798E+02-0.1253*X
        GO TO 2
115        CX=-9.3956E+02+1.5061*X
        PCX=1.5061
        GO TO 2
120        CX=-5.5478E+02+2.2652*X-3.9569E-04*X22
        PCX=2.2652-7.9138E-04*X
        GO TO 2
125        CX=-1.772E+03+6.7132E-01*X+4.9051E-04*X22
        PCX=6.7132E-01+9.8102E-04*X
        GO TO 2
130        CX=-1.2349E+03+8.2977E-01*X+3.3328E-04*X22
        PCX=8.2977E-01+6.6656E-04*X
        GO TO 2
135        CX=2.4989E+03+6.8019E-01*X-2.3247E-04*X22
        PCX=6.8019E-01-4.6494E-04*X
        GO TO 2
140        CX=8.2498E+03-4.7371*X+1.0305E-03*X22
        PCX=-4.7371+2.061E-03*X
        GO TO 2
145        CX=6.2195E+01+2.025*X-3.576E-04*X22
        PCX=2.025-7.152E-04*X
        GO TO 2
150        CX=-1.8259E+03+3.4929*X-6.4062E-04*X22
        PCX=3.429-1.2812E-03*X
        GO TO 2
155        CX=1.9134E+03+1.8377*X-5.9132E-04*X22
        PCX=1.8377-1.1826E-03*X
        GO TO 2
160        CX=3.3612E+03-1.6802E-01*X
        PCX=-1.6802E-01
        GO TO 2
165        CX=-2.4782E+04+2.4486E+01*X-5.3807E-03*X22
```

```
              PCX=2.4486E+01-1.0761E-02*X
              GO TO 2
170              CX=-2.024E+04+9.887*X+5.9886E-03*X22-2.5531E-06*X33
              PCX=9.887+1.1977E-02*X-7.6593E-06*X22
C........
2         YX21=(CY2-CYM)/(CX2-CXM)
C        FX: THE ROOT OF EQUATION FX=0 REPRESENTS THE INTERSECTION POINT
C                BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
         FX=CX-YX21*(X-CXM)-CYM
C        PFX: THE FIRST ORDER DERIVATIVE OF FUNCTION FX.
         PFX=PCX-YX21
C.......
         HG2=X-FX/PFX
C.......
         RETURN
         END
C........
         FUNCTION HG3(X,CXM,CYM,CX2,CY2,CX,II)
C        CX: CURVE FITTING FUNCTION OF LAND.
C        PCX: THE FIRST ORDER DERIVATIVE OF FUNCTION CX.
         X22=X**2
         GO TO (5,10,15,20) ,II
5               CX=-1.0276E+03+2.7043*X-3.9617E-04*X22
              PCX=2.7043-7.9234E-04*X
              GO TO 2
10               CX=1.4385E+04-2.4086E+01*X+1.1224E-02*X22
              PCX=-2.4086E+01+0.02245*X
              GO TO 2
15               CX=3.2185E+04-6.0351E+01*X+2.9644E-02*X22
              PCX=-6.0351E+01+0.05929*X
              GO TO 2
20               CX=2.9224E+02+2.0137*X-6.9034E-04*X22
              PCX=2.0137-1.3807E-03*X
C........
2         YX21=(CY2-CYM)/(CX2-CXM)
C        FX: THE ROOT OF EQUATION FX=0 REPRESENTS THE INTERSECTION POINT
C                BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
         FX=CX-YX21*(X-CXM)-CYM
C        PFX: THE FIRST ORDER DERIVATIVE OF FUNCTION FX.
         PFX=PCX-YX21
C.......
         HG3=X-FX/PFX
C.......
         RETURN
         END
C........
         FUNCTION KG4(X,CXM,CYM,CX2,CY2,CX,II)
C        CX: CURVE FITTING FUNCTION OF LAND.
C        PCX: THE FIRST ORDER DERIVATIVE OF FUNCTION CX.
         X22=X**2
         GO TO (5,10) ,II
5               CX=1.0663E+04-2.5251*X
              PCX=-2.5251
              GO TO 2
10               CX=-4.1427E+03+4.5928*X-7.0553E-04*X22
              PCX=4.5928-1.4111E-03*X
C........
2         YX21=(CY2-CYM)/(CX2-CXM)
```

```
C       FX: THE ROOT OF EQUATION FX=0 REPRESENTS THE INTERSECTION POINT
C              BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
        FX=CX-YX21*(X-CXM)-CYM
C       PFX: THE FIRST ORDER DERIVATIVE OF FUNCTION FX.
        PFX=PCX-YX21
C........
        KG4=X-FX/PFX
C........
        RETURN
        END
C........
        FUNCTION JG3(X,CXM,CYM,CX2,CY2,CX,II)
C       CX: CURVE FITTING FUNCTION OF LAND.
C       PCX: THE FIRST ORDER DERIVATIVE OF FUNCTION CX.
        X22=X**2
        GO TO (5,[illegible],25,30,35,40,45,50,55,60,65) ,II
[illegible]
          [illegible]X-2.0222E-05*X22
          [illegible]E-05*X
          GO TO 2
          CX=[illegible]E+04-4.1094*X+5.1152E-04*X22
          PCX=-4.1094+1.2230E-03*X
          GO TO 2
30        CX=[illegible]E+03-2.0135E-01*X+5.3451E-05*X22
          PCX=-2.0135E-01+1.0690E-04*X
          GO TO 2
35        CX=7.7468E+03-2.5283*X+3.5694E-04*X22
          PCX=-2.5283+7.1388E-04*X
          GO TO 2
50        CX=[illegible]E+03+6.7984E-04*X
          PCX=6.7984E-04
          GO TO 2
55        CX=[illegible]
          [illegible]
          GO TO 2
40        [illegible]-3.6882E-02*X22
          [illegible]
45        [illegible]E+03+[illegible]X
          [illegible]
20        CX=[illegible]E+03-1.[illegible]X
          PCX=-1.[illegible]
          GO TO 2
55        CX=[illegible]E+03+3.3959*X
          [illegible]
          GO TO 2
60        CX=[illegible]E+06-6.[illegible]X+7.4476E-04*X22
          PCX=[illegible]E-03*X
          GO TO 2
65        CX=[illegible]+2.835E-04*X22
          PCX=[illegible]X
[illegible]
C       [illegible] ROOT OF EQUATION [illegible] REPRESENTS THE INTERSECTION POINT
C              BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
```


1418

```
            PCX=-7.4783+3.8466E-03*X
            GC TO 2
              CX=2.6619E+04-2.2131E+01*X+4.7707E-03*X22
            PCX=-2.2131E+01+9.5414E-03*X
            GO TO 2
              CX=1.2097E+04-8.1711*X+1.478E-03*X22
            PCX=-8.1711+2.956E-03*X
            GO TO 2
              CX=-1.6683E+04+7.0599*X
            PCX=7.0599
            GO TO 2
              CX=-5.0065E+04-4.1055E+01*X+8.2543E-03*X22
            PCX=4.1055E+01-0.01651*X
            GO TO 2
              CX=2.2069E+04-1.5963E+01*X+3.0053E-03*X22
            PCX=-1.5963E+01+6.0106E-03*X
            GO TO 2
              CX=-7.9174E+02+2.3377*X-6.4029E-04*X22
            PCX=2.3377-1.2806E-03*X
            GO TO 2
              CX=8.0373E+01+3.3505E-01*X
            PCX=3.3505E-01
            GO TO 2
              CX=-7.5312E+03+7.023*X-1.4403E-03*X22
            PCX=7.023-2.8806E-03*X
            GO TO 2
              CX=1.5906E+04-1.1246E+01*X+2.1109E-03*X22
            PCX=-1.1246E+01+4.2218E-03*X
            GO TO 2
              CX=1.8376E+03-1.7195*X+6.0504E-04*X22
            PCX=-1.7195+1.2101E-03*X
            GC TO 2
              CX=-4.9298E+03+2.5148*X
            PCX=2.5148
            GO TO 2
              CX=-8.7014E+03+1.0202E+01*X-2.4791E-03*X22
            PCX=1.0202E+01-4.9582E-03*X
            GO TC 2
              CX=-5.9147E+03+3.0038*X
            PCX=3.0038
            GO TO 2
              CX=1.3558E+04-5.3534*X-1.8308E-03*X22+8.1866E-07*(X**3)
            PCX=-5.3534-3.6616E-03*X+2.4560E-06*X22
            GO TO 2
              CX=6.9695E+03-6.0591*X+1.5952E-03*X22
            PCX=-6.0591+3.1904E-03*X
C.........
2       YX21=(CY2-CYM)/(CX2-CXM)
C       FX: THE ROOT OF EQUATION FX=0 REPRESENTS THE INTERSECTION POINT
C               BETWEEN CX AND LINE OF MEASURING STATION TO WIND GRID POINT.
        FX=CX-YX21*(X-CXM)-CYM
C       PFX: THE FIRST ORDER DERIVATIVE OF FUNCTION FX.
        PFX=PCX-YX21
C.......
        PG8=X-FX/PFX
C.......
```

```
C-----------------------------------------------------------------------
      SUBROUTINE ANGLE(CXM,CYM,CX2,CY2,ANG)
C     ANG: DIRECTION ANGLE (DEGREES,WITH + X AXIS) OF THE LINE FROM
C          WIND GRID POINT TO MEASURING STATION.
C     (CXM,CYM): COORDINATE OF MEASURING STATION.
C     (CX2,CY2): COORDINATE OF WIND GRID POINT.
      DX=CXM-CX2
      DY=CYM-CY2
      IF(DX .GT. 0 .AND. DY .GT. 0) THEN
              ANG=57.29578*ATAN(DY/DX)
      ELSE IF(DX .LT. 0 .AND. DY .GT. 0) THEN
              ANG=57.29578*ATAN(DY/DX)+180.
      ELSE IF(DX .LT. 0 .AND. DY .LT. 0) THEN
              ANG=57.29578*ATAN(DY/DX)+180.
      ELSE IF(DX .GT. 0 .AND. DY .LT. 0) THEN
              ANG=57.29578*ATAN(DY/DX)+360.
      ELSE IF(DX .EQ. 0 .AND. DY .GT. 0) THEN
              ANG=90.
      ELSE IF(DX .EQ. 0 .AND. DY .LT. 0) THEN
              ANG=270.
      ELSE IF(DX .EQ. 0 .AND. DY .EQ. 0) THEN
              ANG=0.
      END IF
      RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE LONLTD(XA,YA,XB,YB,DIST)
C
C     XA: LONGITUDE OF POINT A.
C     YA: LATITUDE  OF POINT A.
C     XB: LONGITUDE OF POINT B.
C     YB: LATITUDE  OF POINT B.
C     DIST: DISTANCE (KM) FROM POINT A TO POINT B.
C
      XAB=(ABS(XA-XB))*0.0174533
      YYA=(90-YA)*0.0174533
      YYB=(90-YB)*0.0174533
      DD=COS(XAB)*SIN(YYA)*SIN(YYB)+COS(YYA)*COS(YYB)
      IF(DD .GT. 1.0) THEN
             DIST=0.
      ELSE
             DIST=6366.710054*ACOS(DD)
      END IF
      RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE TIMDUR(NYY,NMON,NDD,NHR,KYY3,KMON3,KDD3,KHR3,TD)
C     NYY: YEAR(WERTERN,EX:1987)OF 1ST DATE.
C     NMON: MONTH OF 1ST DATE.
C     NDD: DAY OF 1ST DATE.
C     NHR: HOUR OF 1ST DATE.
C     KYY3: YEAR(WERTERN,EX:1987)OF 2ND DATE.
C     KMON3: MONTH OF 2ND DATE.
C     KDD3: DAY OF 2ND DATE.
C     KHR3: HOUR OF 2ND DATE.
C     TD: TIME DURATION (HR) BETWEEN 1ST DATE AND 2ND DATE.
      DIMENSION MD(12)
      INTEGER TD1,TD2,TD
```


1422

```
      MD(1)=31
      MD(3)=31
      MD(4)=30
      MD(5)=31
      MD(6)=30
      MD(7)=31
      MD(8)=31
      MD(9)=30
      MD(10)=31
      MD(11)=30
      MD(12)=31
      A4=MOD(NYY,4)
      A100=MOD(NYY,100)
      A400=MOD(NYY,400)
      IF ((A4 .EQ. 0 .AND. A100 .EQ. 0 .AND. A400 .EQ. 0) .OR.
     *    (A4 .EQ. 0 .AND. A100 .NE. 0)) THEN
C     THIS YEAR TO BE LEAP YEAR.
          MD(2)=29
          LNYY=1
      ELSE
C     THIS YEAR TO BE ORDINARY YEAR.
          MD(2)=28
          LNYY=2
      END IF
      TD1=0
      DO 100 K=1,NMON-1
         TD1=TD1+MD(K)
100   CONTINUE
      TD1=24*(TD1+NDD-1)+NHR
      A4=MOD(KYY3,4)
      A100=MOD(KYY3,100)
      A400=MOD(KYY3,400)
      IF ((A4 .EQ. 0 .AND. A100 .EQ. 0 .AND. A400 .EQ. 0) .OR.
     *    (A4 .EQ. 0 .AND. A100 .NE. 0)) THEN
C     THIS YEAR TO BE LEAP YEAR.
            MD(2)=29
            LNYY3=1
      ELSE
C     THIS YEAR TO BE ORDINARY YEAR.
            MD(2)=28
            LNYY3=2
      END IF
      TD2=0
      DO 200 K=1,KMON3-1
         TD2=TD2+MD(K)
200   CONTINUE
      TD2=24*(TD2+KDD3-1)+KHR3
      IF(KYY3-NYY .EQ. 1 .AND. LNYY .EQ. 1) TD2=366*24+TD2
      IF(KYY3-NYY .EQ. 1 .AND. LNYY .EQ. 2) TD2=365*24+TD2
      TD=TD2-TD1
      RETURN
      END
C........
```

附錄III 颱風資料

颱風名	年	月	日	時	北緯	東經	中心氣壓
HAL	1985	6	19	14	16.0	132.8	997
				20	16.0	132.8	997
			20	2	16.0	132.8	997
				8	15.0	130.6	984
				14	15.2	129.8	979
				20	15.5	128.8	976
			21	2	15.9	127.8	975
				8	16.3	126.8	969
				14	16.9	125.6	969
				20	17.9	124.2	965
			22	2	18.7	122.8	965
				8	19.1	121.3	965
				14	19.3	120.3	965
				20	19.7	119.7	965
			23	2	20.4	119.0	960
				8	21.1	117.9	955
				14	21.4	116.9	960
				20	21.7	116.1	965
			24	2	21.8	115.4	965
				8	22.1	115.3	970
				14	22.8	115.3	975
				20	23.3	115.1	975
			25	2	23.9	115.1	980

颱風名	年	月	日	時	北緯	東經	中心氣壓
IRMA	1985	6	27	8	15.0	130.1	988
				14	15.8	129.9	985
				20	16.7	129.7	980
			28	2	17.7	129.6	975
				8	18.8	129.7	975
				14	20.0	129.9	965
				20	21.3	129.9	965
			29	2	22.9	130.0	960
				8	24.3	130.2	957
				14	25.7	130.2	957
				20	26.9	130.5	965
			30	2	28.2	131.0	965
				8	29.5	131.8	970
				14	30.9	133.4	970
				20	32.4	135.5	970
		7	1	2	34.8	138.7	970
NELSON	1985	8	18	8	21.0	139.8	990
				14	21.7	139.4	990
				20	22.4	138.5	985
			19	2	22.6	137.5	980
				8	22.7	136.6	979
				14	22.9	135.8	979
				20	23.0	134.9	975
			20	2	23.1	134.0	975
				8	23.1	133.1	975
				14	23.1	132.4	971
				20	23.2	131.6	970
			21	2	23.3	131.0	970

颱風名	年	月	日	時	北緯	東經	中心氣壓
				8	23.7	130.2	970
				14	24.0	129.0	966
				20	24.1	128.0	966
			22	2	24.2	126.9	961
				8	24.5	125.8	963
				14	24.7	124.7	963
				20	24.8	123.8	963
			23	2	25.4	122.8	965
				8	25.5	121.6	965
				14	25.6	120.6	965
				20	25.6	119.8	965
			24	2	25.5	118.4	980
BRENDA	1985	9	30	8	16.5	131.0	999
				14	16.0	131.1	995
				20	15.9	130.3	996
		10	1	2	16.1	130.1	994
				8	16.2	129.9	991
				14	17.2	129.6	989
				20	17.8	129.2	985
			2	2	17.7	128.8	995
				8	17.5	129.0	980
				14	18.3	128.0	980
				20	18.5	127.4	980
			3	2	19.1	126.1	980
				8	19.5	125.6	966
				14	20.6	124.3	964
				20	21.7	123.5	964
			4	2	22.8	123.0	964

颱風名	年	月	日	時	北緯	東經	中心氣壓
BRENDA	1985	10		8	24.7	122.9	964
				14	26.3	122.6	964
				20	27.6	123.5	967
			5	2	29.7	124.3	970
				8	31.8	126.0	970
				14	33.8	128.0	985
				20	35.6	130.5	990
DOT	1985	10	13	14	10.9	146.6	997
				20	11.2	145.1	995
			14	2	11.4	143.6	993
				8	11.6	142.5	992
				14	11.8	141.3	990
				20	12.2	140.1	982
			15	2	12.7	139.0	982
				8	13.1	137.9	969
				14	13.4	136.7	953
				20	13.6	135.6	945
			16	2	13.8	134.9	935
				8	14.1	133.7	935
				14	14.6	132.4	930
				20	14.6	131.2	897
			17	2	14.7	130.0	897
				8	14.6	128.5	897
				14	14.5	127.4	897
				20	14.3	126.3	897
			18	2	14.3	125.3	897
				8	14.5	124.3	915
				14	14.6	123.4	926

颱風名	年	月	日	時	北緯	東經	中心氣壓
				20	15.1	122.3	926
SARAH	1986	7	31	2	15.4	129.0	999
				8	15.5	127.9	998
				14	15.8	127.0	998
				20	16.5	125.6	994
		8	1	2	17.0	124.5	990
				8	17.0	124.6	993
				14	17.3	123.8	992
				20	17.6	123.0	992
			2	2	17.8	122.3	992
				8	17.8	122.3	992
				14	18.0	123.0	992
				20	18.1	123.5	992
			3	2	20.3	126.5	990
				8	20.5	127.5	990
				14	21.3	128.2	990
				20	23.2	130.0	985
			4	2	24.6	131.6	985
				8	27.0	135.8	985
				14	30.2	138.1	985
				20	33.5	139.3	985
			5	2	35.5	141.0	983
VERA	1986	8	13	20	16.7	132.0	998
			14	2	17.0	132.0	998
				8	17.5	131.5	997
				14	17.0	132.0	998
				20	17.9	129.8	996
			15	2	18.3	128.8	996

颱風名	年	月	日	時	北緯	東經	中心氣壓
				8	18.4	128.5	995
				14	18.4	128.2	992
				20	18.5	128.0	992
			16	2	18.6	128.0	992
				8	18.6	129.5	990
				14	19.1	129.3	990
				20	19.1	129.1	988
			17	2	19.0	129.1	988
				8	18.5	129.5	988
				14	19.1	130.9	990
				20	19.7	132.2	993
			18	2	20.3	136.5	987
				8	22.6	136.0	980
				14	22.9	136.5	980
				20	23.2	137.5	980
			19	2	23.9	138.0	985
				8	23.9	138.0	985
				14	23.4	137.7	985
				20	23.2	137.9	985
			20	2	22.0	140.2	985
				8	21.7	141.5	970
				14	21.7	141.9	965
				20	21.7	142.5	963
			21	2	21.9	143.1	963
				8	21.3	143.3	960
				14	21.5	144.1	948
				20	21.8	144.7	944
			22	2	21.8	144.9	940

颱風名	年	月	日	時	北緯	東經	中心氣壓
				8	22.0	145.5	932
				14	22.2	145.7	923
				20	22.2	145.7	925
			23	2	22.2	145.5	930
				8	22.3	144.5	930
				14	22.3	143.5	935
				20	22.3	142.4	935
			24	2	22.2	140.9	935
				8	22.1	140.0	935
				14	22.5	138.5	935
				20	22.9	136.9	935
			25	2	23.4	135.4	940
				8	24.0	133.5	950
				11	24.1	132.8	950
				14	24.3	132.0	950
				17	24.6	131.7	950
				20	24.9	130.7	950
				23	25.1	129.7	950
			26	2	25.3	128.8	950
				5	25.5	128.1	950
				8	26.0	127.4	950
				11	26.2	126.8	950
				14	26.5	126.3	955
				17	26.9	125.5	955
				20	27.2	124.8	955
			27	2	27.6	124.2	955
				8	28.6	123.5	955
				14	29.6	123.7	955

颱風名	年	月	日	時	北緯	東經	中心氣壓
				20	30.8	124.0	960
			28	2	32.4	124.4	960
				8	33.9	125.8	965
				14	35.6	125.9	965
				20	37.5	127.0	965
ABBY	1986	9	13	20	12.2	144.7	996
			14	2	13.1	143.8	996
				8	14.0	140.0	996
				14	15.0	139.0	995
				20	15.4	136.2	990
			15	2	15.9	135.2	990
				8	16.5	134.4	985
				14	17.4	133.0	985
				20	18.1	131.7	985
			16	2	18.5	130.7	980
				8	19.0	130.0	975
				14	19.6	128.9	975
				20	19.3	128.1	970
			17	2	19.0	127.2	970
				8	19.8	126.8	965
				14	20.4	125.8	953
				20	20.7	125.8	953
			18	2	20.9	124.9	953
				8	21.2	124.2	953
				14	21.8	123.3	950
				20	22.2	122.5	945
			19	2	22.7	121.9	945
				8	23.2	121.1	950

颱風名	年	月	日	時	北緯	東經	中心氣壓
				14	23.9	121.0	950
				20	24.3	120.3	960
			20	2	25.2	120.5	970
				8	26.1	121.4	982
				14	27.0	122.8	985
				20	29.0	123.4	990
			21	2	31.5	125.5	997

年	月	日	時	分	$H_{1/3}$(米)	$T_{1/3}$(秒)	站
			21	0	2.70	12.33	B
		29	0	0	2.24	10.93	〃
			3	0	1.96	10.86	〃
			6	0	1.68	11.50	〃
			9	0	2.14	11.15	〃
			12	0	2.24	10.84	〃
			15	0	1.90	10.47	〃
			18	0	1.64	9.64	〃
			21	0	1.48	9.44	〃
		30	0	0	1.12	8.67	〃
			3	0	1.05	8.69	〃
			6	0	0.96	8.73	〃
			9	0	1.01	8.98	〃
1985	8	21	0	0	1.30	10.74	A
			15	0	1.31	10.47	〃
			16	4	1.60	10.99	〃
			17	8	1.57	10.03	〃
			18	12	1.87	11.39	〃
			19	0	1.61	11.36	〃
			20	4	1.47	10.55	〃
			21	8	1.60	10.25	〃
			22	12	1.90	11.54	〃
			23	0	1.77	10.39	〃
			23	48	2.13	10.26	〃
		22	0	4	2.13	9.91	〃
			1	8	1.95	9.97	〃
			2	12	1.76	9.18	〃
			3	0	1.77	10.14	〃

附錄Ⅳ蘇澳波浪資料

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）	站
1985	6	21	6	0	1.24	8.89	B
			9	0	1.26	9。29	〃
			12	0	1.46	9.77	〃
			15	0	1.54	9.74	〃
			18	0	1.72	10.28	〃
			21	0	2.10	10.32	〃
		22	0	0	2.85	11.63	〃
			3	0	3.43	11.72	〃
			6	0	3.83	13.23	〃
			9	0	6.06	13.86	〃
			12	0	6.43	13.41	〃
			15	0	6.11	12.81	〃
			18	0	4.82	12.60	〃
			21	0	4.18	10.69	〃
		23	0	0	3.96	9.00	〃
			3	0	3.47	9.04	〃
			6	0	3.73	9.93	〃
			9	0	3.15	8.91	〃
			12	0	3。25	8.73	〃
			15	0	3.20	9.55	〃
			18	0	2.44	7.91	〃
			21	0	2.39	8.64	〃
		24	0	0	2.50	8.87	〃
			3	0	2.46	8.32	〃
	6	28	12	0	1.41	9.22	〃
			15	0	1.38	9.24	〃
			18	0	1.66	10.37	〃

年	月	日	時	分	H⅓(米)	T⅓(秒)	站
			14	54	1.96	9.43	A
			15	58	2.31	9.56	〃
			17	2	2.77	9.13	〃
			18	6	2.16	9.09	〃
			19	10	2.72	9.54	〃
			20	14	2.22	10.03	〃
			21	2	2.23	8.81	〃
			22	6	1.83	8.72	〃
			23	10	2.05	9.27	〃
			23	58	2.05	9.44	〃
		24	0	14	1.78	8.70	〃
			1	2	2.16	8.98	〃
			2	4	2.19	9.02	〃
			3	8	2.26	8.69	〃
1985	8	24	3	56	2.03	8.67	〃
			5	0	2.46	8.75	〃
	10	3	14	7	2.79	10.65	B
			15	59	3.32	10.28	〃
			18	7	3.81	11.86	〃
			19	59	5.20	12.37	〃
			20	47	7.08	14.04	〃
			21	35	5.97	14.30	〃
			21	51	6.69	15.23	〃
			22	7	6.11	14.73	〃
			22	39	6.77	15.24	〃
			23	11	7.58	15.93	〃
			23	43	7.44	15.49	〃

年	月	日	時	分	$H_{1/3}$(米)	$T_{1/3}$(秒)	站
			4	4	1.83	11.24	〃
			5	8	1.56	9.71	〃
			6	12	1.91	9.91	〃
			7	0	1.80	10.08	〃
			8	4	2.07	10.33	〃
			9	8	1.94	9.44	〃
			10	12	2.30	11.01	〃
			11	0	2.30	10.88	〃
			12	4	2.98	10.66	〃
			13	8	2.72	10.81	〃
			13	40	2.76	11.65	〃
			13	59	3.41	11.06	〃
			15	3	2.79	10.23	〃
			16	7	3.44	10.63	〃
			16	55	3.46	11.28	〃
			17	59	3.87	11.71	〃
			19	3	3.63	12.37	〃
			20	7	4.10	11.77	〃
			20	55	4.35	12.60	〃
			21	59	4.54	12.58	〃
			23	3	4.66	12.60	〃
			23	51	4.85	12.94	〃
		23	0	7	4.72	12.06	〃
			0	55	4.84	12.38	〃
			1	59	4.49	11.91	〃
			3	3	3.94	11.42	〃
			3	57	3.24	10.66	〃
			9	57	1.73	8.90	〃

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）	站
			23	59	8.23	15.32	〃
		4	0	15	6.74	15.08	〃
			1	3	5.74	14.09	〃
			2	7	7.09	14.99	〃
			3	11	7.69	16.31	〃
			4	15	6.42	15.06	〃
			5	3	7.98	15.25	〃
			6	7	8.63	14.81	〃
			7	11	7.41	15.63	〃
			7	59	6.51	14.25	〃
			8	47	4.88	14.08	〃
			9	8	6.40	13.72	〃
			9	56	4.53	11.87	〃
			11	0	4.97	12.52	〃
			12	4	4.04	10.97	〃
			13	8	3.66	10.62	〃
			14	12	3.51	9.79	〃
			15	0	3.19	10.05	〃
			16	4	3.62	10.35	〃
			17	8	2.65	10.06	〃
			18	12	2.93	9.02	〃
			19	0	2.07	9.33	〃
			20	4	2.22	11.29	〃
			21	8	1.99	11.07	〃
			22	12	1.92	9.52	〃
			23	0	2.09	9.47	〃
			23	48	2.14	9.33	〃
		5	0	4	2.19	8.87	〃
			2	12	1.54	9.22	〃

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）	站
			3	0	1.86	9.55	〃
			4	4	1.66	9.38	〃
			5	8	2.35	9.55	〃
			5	56	2.20	9.25	〃
			7	0	2.12	8.94	〃
			8	4	1.84	8.87	〃
			9	8	2.13	8.47	〃
			9	56	2.53	8.58	〃
			10	44	2.02	8.33	〃
		18	0	0	1.67	10.25	〃
			3	0	2.41	10.69	〃
			6	0	2.40	10.91	〃
			12	0	2.38	9.37	〃
			21	0	1.97	9.74	〃
		19	0	0	2.33	11.09	〃
			6	0	2.45	11.83	〃
			12	0	1.84	10.40	〃
			15	0	1.50	10.66	〃
			18	0	1.85	10.64	〃
			21	0	1.78	7.91	〃
		20	0	0	1.95	8.24	〃
			3	0	1.83	7.81	〃
			6	0	1.76	8.87	〃
			9	0	1.73	8.67	〃
			12	0	1.60	8.22	〃
			15	0	1.53	8.23	〃
			18	0	1.45	7.29	〃
		21	0	0	1.47	7.94	〃
			9	0	1.37	7.53	〃

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）	站
			21	0	1.52	7.89	〃
1985	10	22	6	0	1.24	7.22	〃
			12	0	1.46	8.40	〃
			21	0	1.74	6.75	〃
1986	8	2	4	0	2.33	9	
			5	0	2.17	9	
			6	0	2.06	9	
			7	0	1.61	8	
			8	0	1.75	8	
			9	0	1.82	8	
			10	0	1.70	8	
			11	0	2.34	7	
			12	0	2.04	8	
			13	0	2.04	8	
			14	0	2.47	9	
			15	0	2.40	9	
			16	0	2.74	9	
			17	0	2.55	9	
			18	0	2.24	8	
			19	0	2.57	9	
			20	0	2.46	9	
			21	0	2.26	9	
			22	0	2.77	9	
			23	0	2.85	10	
		3	0	0	2.99	9	
			1	0	2.93	9	
			2	0	2.41	9	
			3	0	2.57	9	
			4	0	2.48	10	

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）
			5	0	2.80	9
			6	0	1.92	9
			7	0	2.66	10
			8	0	2.64	10
			9	0	1.96	9
		17	0	0	2.31	9
			5	0	1.72	9
			7	0	2.25	10
			9	0	1.78	9
			11	0	2.19	10
			13	0	2.03	10
			15	0	2.23	10
			17	0	1.81	9
			19	0	1.67	9
			23	0	2.07	9
		18	4	0	1.83	10
			7	0	2.04	10
			13	0	1.86	10
			16	0	1.67	9
			21	0	1.36	9
		19	0	0	1.72	11
			4	0	1.34	10
			7	0	1.34	9
			8	0	1.60	10
			9	0	1.71	13
			10	0	1.39	10
			14	0	1.21	10
			16	0	1.44	11
			19	0	1.29	10

年	月	日	時	分	$H_{1/3}$（米）	$T_{1/3}$（秒）
			20	0	1.47	9
			22	0	2.03	12
		20	3	0	1.45	10
			10	0	1.29	11
			12	0	1.02	9
			13	0	1.19	9
		25	2	0	1.81	9
			4	0	1.92	10
			5	0	1.68	9
			7	0	1.93	10
			9	0	1.51	9
			10	0	1.52	9
			11	0	1.73	9
			12	0	1.49	10
			13	0	1.65	9
			14	0	1.62	10
			20	0	1.48	9
			22	0	1.22	9
			23	0	1.59	12
		26	0	0	1.53	12
			1	0	1.55	12
			1	40	1.79	13
			2	20	2.02	13
			4	0	1.86	12
			5	0	1.97	12
			6	0	2.18	12
			7	0	2.11	13
			7	40	3.00	14
			9	0	2.98	13

年	月	日	時	分	H⅓（米）	T⅓（秒）
			10	40	2.08	12
			12	20	2.33	11
			13	0	2.49	10
			14	20	3.12	7
			16	20	2.38	11
			18	0	2.34	12
			19	0	2.52	12
			20	0	3.48	12
			21	0	3.21	12
			22	0	2.80	12
			23	0	2.84	12
			23	20	3.17	13
			23	40	2.37	12
		27	0	0	2.22	11
			0	40	2.08	12
			2	0	2.16	12
			3	0	1.72	10
			4	0	1.50	10
			5	0	1.32	8
			6	0	1.38	11
			7	0	1.31	10
			8	0	1.33	10
			9	0	1.17	10
			10	0	1.01	8
			11	0	0.94	9
			12	0	1.01	9
			14	0	1.22	9
			16	0	1.15	9
			18	0	1.10	8

年	月	日	時	分	$H_{1/3}$ (米)	$T_{1/3}$ (秒)
	9	17	5	0	3.13	12
			6	0	3.34	12
			7	0	3.00	11
			8	0	3.63	10
			8	40	3.62	12
			9	0	4.19	26
			9	20	3.09	11
			10	10	2.56	10
			11	0	2.64	10
			11	10	3.48	13
			11	30	3.32	11
			11	50	3.71	9
			12	0	3.38	12
			12	10	3.07	11
			12	40	3.21	10
			13	10	2.95	11
			14	0	2.97	8
			17	0	3.19	8
			19	0	3.37	10
			21	20	3.01	9
			23	0	2.83	8
		18	1	0	2.76	6
			1	30	3.97	10
			3	0	2.96	6
			5	0	2.77	7
			7	0	3.42	9
			8	40	3.14	8
			9	30	3.87	10
			9	50	3.05	12

年	月	日	時	分	$H_{1/3}$(米)	$T_{1/3}$(秒)
			11	30	5.29	8
			12	10	4.34	10
			12	40	4.19	11
			12	50	4.92	14
1986	9	18	13	20	4.23	7
			14	0	5.05	12
			14	10	3.95	8
			14	40	5.09	10
			15	0	4.42	6
			15	10	4.78	11
			15	20	5.08	13
			15	40	6.22	11
			16	0	7.17	15
			16	20	5.71	7
			16	50	5.11	9
			17	0	5.90	11
			17	40	6.30	8
			18	20	5.62	11
			18	50	6.36	12
			19	10	6.40	12
			19	20	8.71	8
			19	30	6.06	14
			19	40	5.77	12
			20	0	6.73	15
			20	40	4.75	10
			21	0	5.15	8
			21	50	6.29	12
			22	30	5.60	10

年	月	日	時	分	$H_{1/3}$(米)	$T_{1/3}$(秒)
			23	20	5.76	9
			23	50	5.64	11
1986	9	19	0	0	4.73	9
			0	10	9.93	15
			0	20	5.65	18
			0	30	9.66	9
			0	40	11.61	28
			2	0	6.83	7
			2	30	11.62	12
			2	50	9.98	9
			3	40	12.47	12
			4	0	6.85	10
			4	30	6.10	9
			5	20	6.72	10
			5	40	7.67	11
			6	10	5.48	7
			7	0	6.67	9
			7	20	9.35	15
			7	40	6.53	10
			8	10	7.05	10
			8	30	6.28	13
			8	50	7.84	12
			10	0	7.67	11
			10	20	7.27	15
			10	30	7.55	13
			10	50	6.54	8
			11	0	6.43	10
			11	10	8.43	14

年	月	日	時	分	$H_{1/3}$(米)	$T_{1/3}$(秒)
1986	9	19	11	40	7.27	11
			12	0	7.12	13
			12	10	6.54	10
			12	30	6.02	7
			13	0	6.25	10
			13	20	6.68	9
			14	0	6.73	11
			15	0	7.21	11
			16	0	7.30	10
			18	0	5.35	6
			20	0	4.64	8
			22	0	3.00	9
			23	0	2.55	9
		20	0	0	3.45	9
			2	0	2.73	7
			4	0	2.66	10
			6	0	2.47	9
			10	0	1.97	8