相對於輕度颱風中心位置之民航機場的風場

童茂祥

摘要

侵台颱風對台灣的危害，不僅挾帶的暴雨能造成水災，另外伴隨而來的強風同樣也會造成重大破壞，尤其對於民眾賴於通行的陸上及空中交通運輸系統，亦常因安全考慮而停擺，造成民眾行的不便及運輸業者的營運損失。

在2008年以前，颱風作業期間的風場預報方法，大都是參考當時僅有的概括性的區域統計資料，但在實際作業時發現並不能符合民航氣象作業的需求，亦無法提供給各家航空公司作為營運參考方針。有鑑於此，臺北航空氣象中心於2008年完成「侵台颱風對各民航機場的風場統計」研究計劃，並納入正式例行作業系統。之後，於作業期間利用此風場搜尋系統的統計值來預測各民用機場的最大風速、最大陣風與風向的時間序列變化。同時，經與實際天氣報告比對後，發現其間的誤差很小，證實此系統的確具備很好的參考價值。

本研究之目的是為能在颱風侵台期間，預報48小時以上之民用機場的風場變化供航空公司作業參考使用。利用上述風場統計系統，於2014年8月製作完成相對於輕度颱風中心位置之民航機場的風場統計。9月正好鳳凰輕度颱風侵台，當颱風中心接近台灣南端海上時，依據國內外發布的預測未來路徑製作72小時預報風場的時間序列以便用來比對。雖然此次颱風中心登後的路徑預報並不理想，但相對風場的統計資料經與實際風場比對後，發現預報的相對風場與實際風場的差距很小，在風向變化方面都能掌握。確認此相對風場統計具有很好參考價值，同時顯示正確的颱風移動路徑預報,更能發揮其功能。

一、前言

當颱風侵襲臺灣期間能完全掌握與正確預報民用機場的風場變化，一直是臺北航空氣象中心(以下簡稱氣象中心)探討的重要課題之一。以往例行作業中，主要都依賴預報員經驗的主觀預報，但由於颱風環流並非正圓形，再加上未考慮到地形因素的影響，往往會造成預報的誤差。因此，建立一個客觀預報參考資料是有其必要性。

國內氣象作業單位曾利用多年在颱風期間的各地測站資料，仔細分析颱風和各測站間的流場分布與颱風位置之關係，建立起八大西行侵台颱風流場類型與程序，但是倘若仔細地研讀其研究內容，不難發現對於流場分析的尺度只是一個概括性區域性質的統計，而區域的範圍，大至可以含蓋整個西半部，小至可達一個縣市。這樣對於民航實際氣象作業的效用來說，雖具有參考價值，但卻不夠精確，仍不符合各個民航機場對於風場預報的期待。

有鑑於此，氣象中心認為既然原參考的研究成果脫離民航氣象現實，那何不自行著手整理。在颱風侵台期間各個民航機場受颱風風力影響之情形，除了有利於增進觀測員在颱風期間，對機場風力特性的認知之外，亦可以有效地協助預報員編報颱風警報與各式航空氣象報文。另外，更可以提供各家航空公司作為其營運參考方針。

2006年氣象中心開始收集資料並加以分析，2007年向民航局提出「侵台颱風對各民航機場的風場統計」自行研究計劃，在2008年5月底完成統計分析，然後於7～9月經過布拉萬(0802)、卡玫基(0807)及鳳凰(0808)等颱風的考驗，於作業期間利用此風場搜尋系統的統計值來預測機場24小時內的最大風速、最大陣與風向的時間序列變化，經與實際天氣報告比對後，其間的誤差很小，證實此系統的確具備很好的參考價值，同時於年底完成研究報告。

接著於2011年提出「颱風接近期間各機場風力類神經網路分析系統建置及應用」自行研究計劃，且於2011年底完成研究報告。此研究計劃的內容主要是延續與利用2008年研究計劃的成果，再運用類神經網路的非線性迴歸特質並加入便捷的時間軸輸入與內插功能，進一步研究建立一個能與颱風風場查詢系統相互驗證而且適合氣象人員實務作業中使用的颱風接近期間機場風場預報系統。將許多繁雜的計算和輸入加以簡化及自動化，就是希望能幫助預報人員在颱風接近

期間特別忙碌的工作之中能有效且穩定的製作機場預報和風力預報作業。

之後於2012年與2013年間在颱風侵襲台灣期間，預報員充分利用兩種風場預報方法的互補下，發布正確的預報風場提供管制、航站及航空公司參考，獲得好評。

氣象中心依據作業規範，於例行作業中僅在發布颱風警報階段時才會正式提供48小時的風場預報供航空公司參考，但有時會接到航空公司提出超過72小時或更長時間的風場預報需求，雖然預報的時段已遠超出作業規範，但為了加強航空氣象的服務，預報員在百忙中仍盡力滿足航空公司的需求。因此，為提升提供預報的效率與準確率，擬建立對應於颱風中心位置之民航機場出現的風場，供較長時段之預報參考。

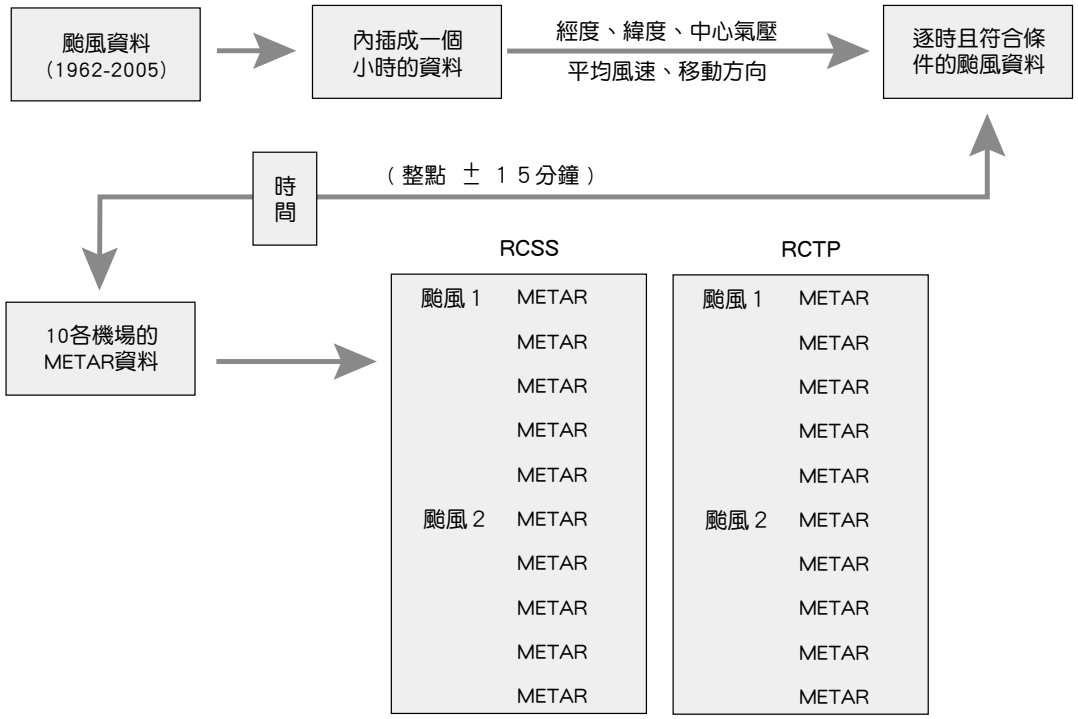
二、研究方法

本文計算風場平均值的方法是將「侵台颱風對各民航機場的風場統計」研究成果加以延伸利用。因此需要提到該研究的兩項觀點(有關該研究的詳細內容，請參閱2008年民航局研究報告)，才能了解本文的風場平均值所代表意義，以及因受原始資料的限制，造成那些區域內為何並無對應的風場資料。

(一) 資料處理流程

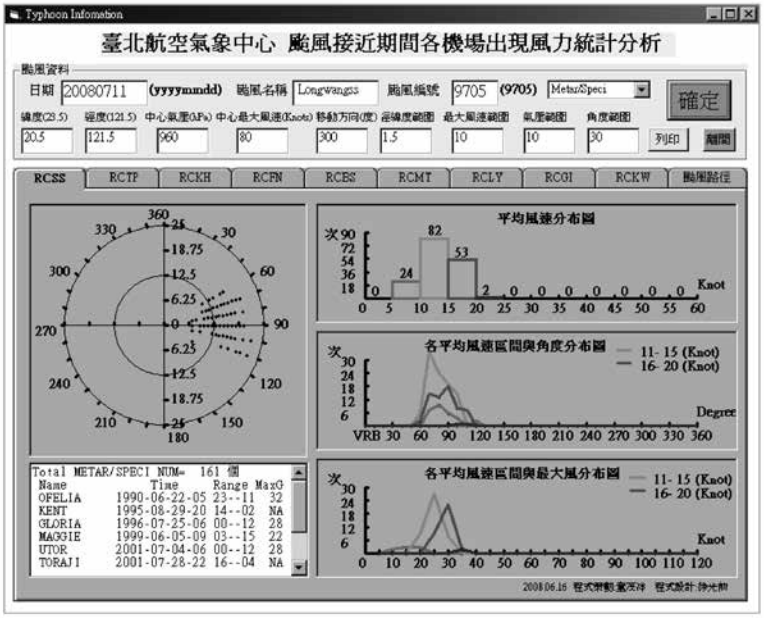
使用到兩種資料：第一種是氣象中心所屬的10個航空氣象台逐年的定時機場天氣報告與特別天氣報告，另一種是從台灣大學大氣研究資料庫中所得到的各年侵台颱風資料。雖然侵台颱風的資料期間是從1958年至2007年共50年，但是由於各個航空氣象台建站時間不一，因此在作個別資料比對的時候，較晚成立的氣象台因為所含蓋年份較短，可想而知的，其所符合的資料數目必定會比較少，也可能會影響其統計結果。資料的處理過程如圖1，風場搜尋與顯示版面如圖2。

圖1：資料處理流程



(二)颱風接近期間各機場出現風場的搜尋與顯示版面

圖2：颱風接近期間各機場出現風場的搜尋與顯示版面



(三) 研究步驟：

1.規劃輸入資料的密度與分析結果的顯示方式：

(1) 平均風場的來源：風場平均值的計算方法是利用「侵台颱風對各民航機場的風場統計」研究計劃所使用的資料庫，1958至2007年之50間為1958至2007年之50年間共238個颱風資料(10°N～35°N，115°E～150°E範圍內)，統計分析方法則利用颱風接近期間各機場出現風場的搜尋與顯示程式。

(2) 平均風場的顯示圖表：為能容易閱讀且具有代表性的顯示，風場顯示圖的格式定為經緯度各0.1度的網格點。當經緯度為整數時格線以實線表示，0.5度則為虛線，其餘僅用點表示。

(3) 顯示圖表的範圍：考慮到因為氣象中心所儲存資料庫範圍的限制,以及能符合72小時以上預報的需求，顯示圖表的範圍定在經度27.5°N～20.5°N，緯度在117.5°E～124.5°E之間。

(4) 輸入資料網格點的間距：輸入格點之格距，經測試後以經緯度各為0.5度最為理想。格距太小不僅過於費時，且會有資料遺漏未加入計算。格距太大，導致資料過度重複計算的現象發生。格點四周涵蓋的範圍，以0.25度的間距最為理想，不僅資料不會重複計算且沒有資料遺漏現象。

(5) 先行處理輕度颱風：由於分析過程中需要輸入大量資料及研判每一點的統計值，是一件費時的工作，另外重要的一點，尚不知其效益是否可達到預期的效果，因此僅先行探討輕度颱風的情況。之後在依使用者意見，再行評估是否需要延伸至中度颱風。

2.輸入資料的定義：

(1) 中心氣壓：輕度颱風最大風介於34KT～63KT間，取中間值50KT，而相對的中心氣壓約為985hPa

(2) 最大風速：50KT

(3) 移動方向：360°

(4) 經緯度範圍：經度與緯度間距為0.25°

(5) 最大風速範圍：±10KT

(6) 氣壓範圍：±10hPa

(7) 角度範圍：360

3.風力統計的分析研判

於颱風接近期間各機場出現風場的搜尋與顯示版面輸入資料後，出現風力統計結果如見圖2，圖中左邊為風盤上顯示所有資料的出現點，右邊平均風速分布圖、各平均風速區間與角度分布圖及各平均風速區間與最大風分布圖。研判規則如下：見圖2之案例，颱風中心移動至北緯20.5度東經 121.5時，松山機場風向出現的次數在060°～110°間最多，但風向是一種向量，取平均值是毫無意義，因此選取頻率最高的070° 為代表。相對的風速在10KT～20KT間，而最大陣風可達到40KT。因此，此經緯度風場標記為070/20G40。

三、統計分析結果的風場顯示(圖3~圖13)

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯

松山機場RCSS

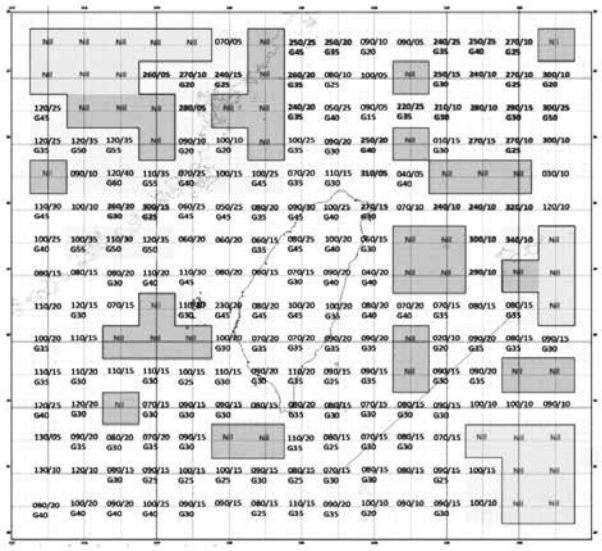


圖3：對應於輕度颱風中心位置之松山機場出現的風場(網格點為經緯度的整點與半點)。統計天氣資料包括，每日06L～24L的整點與半點定時觀測(00L~06L無半點)及特別觀測。

1. 西風系統(180° ～360°)以紅色字體表示。
2. 東風系統(010° ～170°)以黑色字體表示。
3. 陣風50KT～69KT以黃色網底表示。
4. 陣風>70KT以淺紅色網底表示。
松山機場出現50KT～55KT陣風的時期，是在輕度颱風中心位置到達119° E～118° E，24° N～26° N

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。
2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。
3.統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

桃園機場RCTP

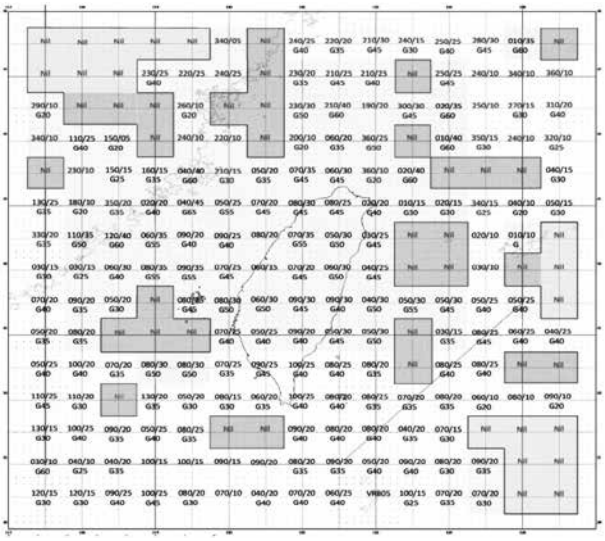


圖4：對應於輕度颱風中心位置之桃園機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日00L～24L的整點與半點定時及特別天氣觀測。

1. 西風系統(180° ～360°)以紅色字體表示。
2. 東風系統(010° ～170°)以黑色字體表示。
3. 陣風50KT~69KT以黃色網底表示。
4. 陣風>70KT以淺紅色網底表示。
桃園機場出現50KT～65KT陣風的時期，是輕度颱風中心在登陸台東陸地之前後區域、離開陸地移至台灣海峽上與東北部近海上。

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。
2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

高雄機場RCKH

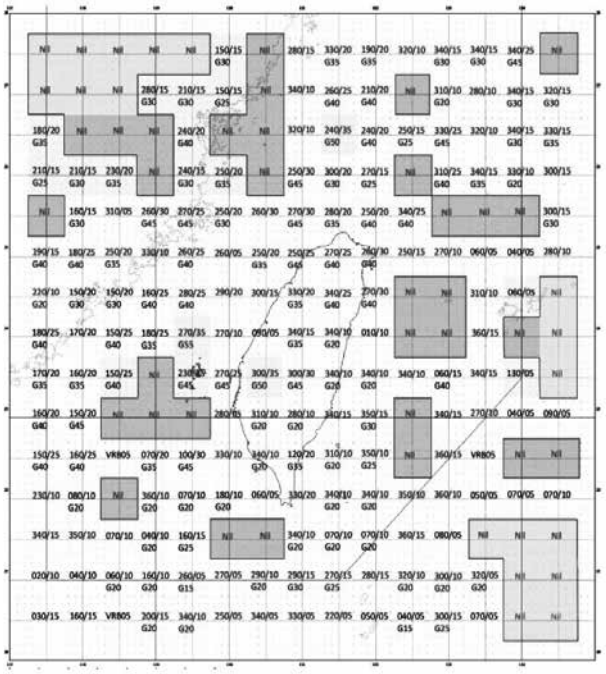


圖5：對應於輕度颱風中心位置之高雄機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日06L～24L的整點與半點定時觀測(00L~06L無半點)及特別觀測。

1. 西風系統(180° ～360°)以紅色字體表示。

2. 東風系統(010° ～170°)以黑色字體表示。

3. 陣風50KT～69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

高雄機場受中央山脈影響，出現50KT～55KT陣風的時期，是在輕度颱風中心移至24° N～25° N、121° E～119° E區域，此刻西南風才增強。

1. Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2. 網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3. 統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

豐年機場RCFN

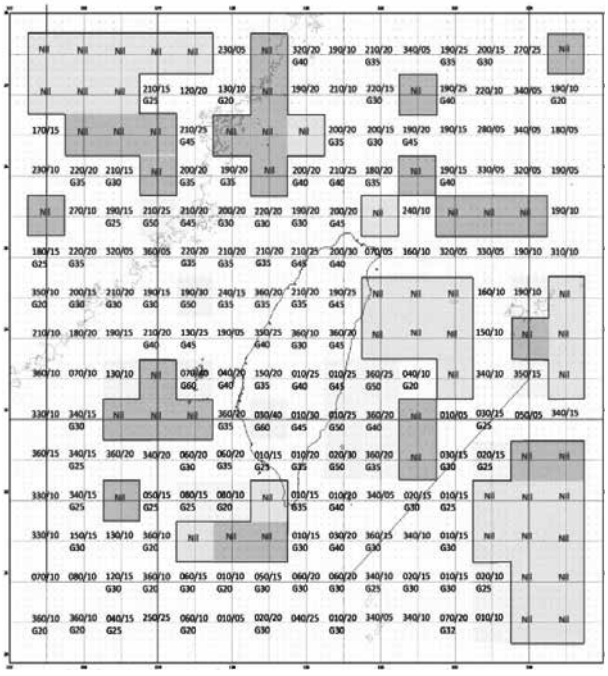


圖6：對應於輕度颱風中心位置之豐年機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日06L～20L的整點與半點定時觀測及特別觀測。

1. 西風系統(180° ～360°)以紅色字體表示。

2. 東風系統(010° ～170°)以黑色字體表示。

3. 陣風50KT～69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

豐年機場受台東縱谷影響，出現50KT陣風的時期，是在輕度颱風中心出現在東部近海時，盛行北風時期；另外，颱風中心出現南部陸地及近海處時，豐年機場會出現60KT的陣風。

1. Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2. 網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3. 統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

金門機場RCBS

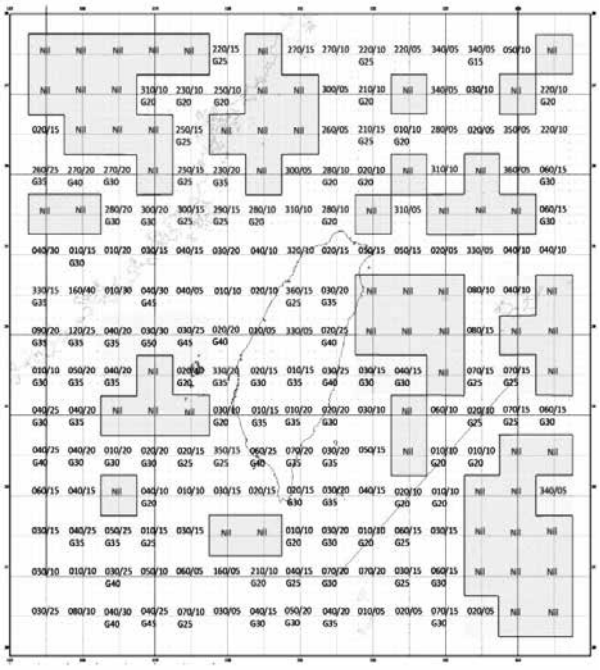


圖7：對應於輕度颱風中心位置之金門機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日06L～20L的整點與半點定時觀測及特別觀測。

1. 西風系統(180°～360°)以紅色字體表示。

2. 東風系統(010°～170°)以黑色字體表示。

3. 陣風50KT~69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

金門機場現50KT陣風的時期，在輕度颱風中心出現金門機場東南方近海時。

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3.統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

北竿機場RCMT

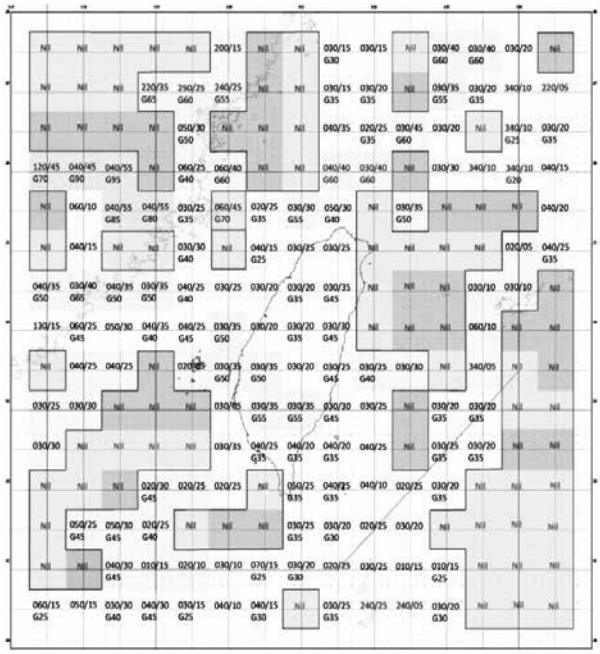


圖8：對應於輕度颱風中心位置之北竿機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日06L～19L的整點定時觀測及特別觀測。

1. 西風系統(180°～360°)以紅色字體表示。

2. 東風系統(010°～170°)以黑色字體表示。

3. 陣風50KT~69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

當輕度颱風中心出現在南部陸地及北竿機場南方時，北竿機場出現50KT～65KT陣風；另外，當颱風中心出現在台灣東北部近海時亦相同。如颱風中心移至北竿機場西方時，北竿機場會出現70KT～90KT強陣風。

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3.統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

蘭嶼機場RCLY

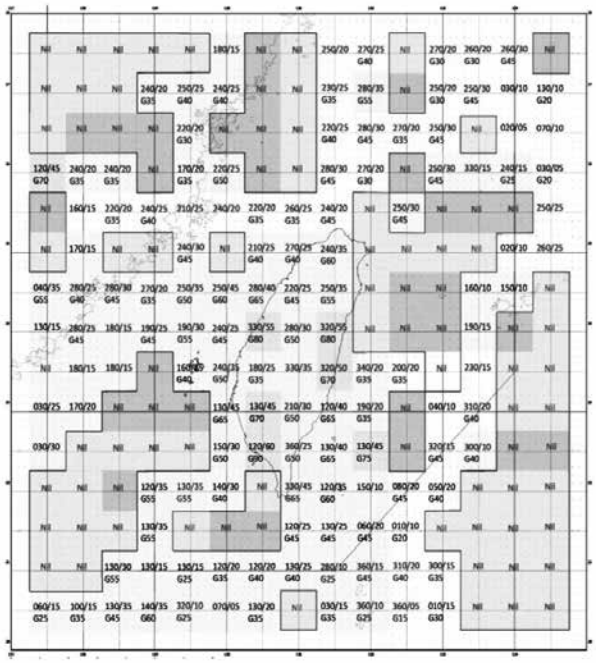


圖9：對應於輕度颱風中心位置之蘭嶼機場出現的風場(網格點為經緯度的整數與半點）。統計天氣資料包括，每日07L～17L的整點定時觀測及特別觀測。

1. 西風系統(180°～360°)以紅色字體表示。

2. 東風系統(010°～170°)以黑色字體表示。

3. 陣風50KT~69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

當輕度颱風中心接近蘭嶼機場及在登陸台灣東部陸地時，蘭嶼機場出現75KT~80KT強陣風；另外，登陸台灣南部陸地時，蘭嶼機場更曾出現70KT～90KT強陣風。如颱風中心移至北部地區及台灣海峽時，蘭嶼機場亦會有50KT～65KT陣風。

1. Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2. 網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3. 統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

綠島機場RCGI

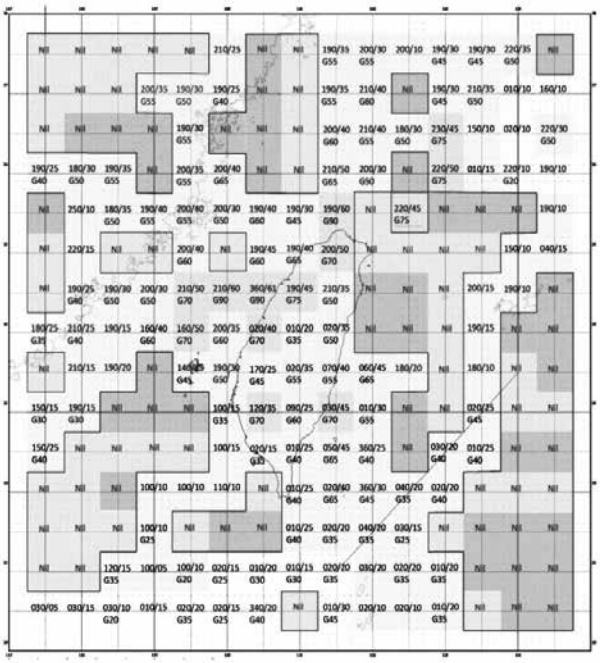


圖10：對應於輕度颱風中心位置之綠島機場出現的風場。(網格點為經緯度的整數與半點）。統計天氣資料包括，每日07L～17L的整點定時觀測及特別觀測。

1. 西風系統(180°～360°)以紅色字體表示。

2. 東風系統(010°～170°)以黑色字體表示。

3. 陣風50KT～69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

當輕度颱風中心接近綠島機場前後及在登陸台灣南部陸地時，綠島機場有75KT～80KT強陣風；另外，颱風中心在北部陸地與北部西方的海峽時，綠島機場有70KT～90KT強陣風。如颱風中心移至北部外海廣大區域內，綠島機場有50KT～65KT陣風。

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3.統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

恆春機場RCKW

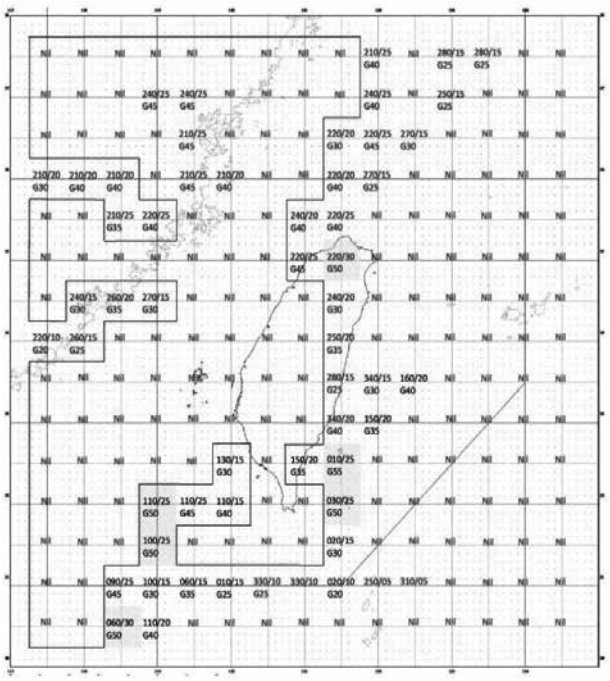


圖11：對應於輕度颱風中心位置之恆春機場出現的風場(網格點為經緯度的整數與半點)。統計天氣資料包括，每日11L～17L的整點定時觀測及特別觀測。

1. 西風系統(180°～360°)以紅色字體表示。

2. 東風系統(010°～170°)以黑色字體表示。

3. 陣風50KT～69KT以黃色網底表示。

4. 陣風>70KT以淺紅色網底表示。

恆春機場資料很少，但從有限資料中仍可看出，當輕度颱風中心接近綠島機場前後、在台灣南部外海時及北部陸地時，恆春機場出現50KT~55KT陣風。

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。

2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。

3.統計資料自1958至2007年共238個颱風。童茂祥2014

圖3至圖11上陣風大小與平均風有很好關聯性，也就是陣風強時平均風亦大。

圖3至圖11分別為松山、桃園、高雄、豐年、金門、北竿、蘭嶼、綠島及恆春等9個民用機場對應於輕度颱風中心位置之風場，但缺少南竿、望安及七美機場資料的原因，主要是南竿氣象臺成立較晚儲存資料較短，統計資料代表性較低，而且距離北竿機場很近可參考北竿資料；另外望安及七美機場因僅為簡易天氣觀測，加上並非每日觀測，因此統計資料更無代表性，故原先規劃時就不處理。

9個民用機場內的氣象臺其個自成立時間不同，加上每日觀測時段也長短不一，因而儲存天氣資料的密度當然也不同。其中以松山、桃園及高雄3個機場的資料最為完整；豐年與金門機場次之，因成立時間較晚而且夜間無觀測資料(早期一段時間曾有夜間觀測，後來停掉)；北竿、蘭嶼與綠島機場再次之，因氣象臺不僅成立時間又更晚，而且觀測時段又更短；恆春機場的天氣資料的密度最差，歸因氣象臺每日僅有7小時觀測資料。

由圖3至圖11中不難發現氣象臺所儲存的天氣資料密度與風場顯示有很大相關，密度愈低在圖中出現的Nil區域愈多，因為程式在資料庫中找不到符合條件的天氣資料。

另外，圖12與圖13為對應於颱風中心位置之松山及北竿機場出現的風場，但加上經緯度各0.25度網格點的統計資料，期望能有更多輸出資料可供參考。由兩張圖與原始圖比對下，可發現對於Nil區域的資料增加有限，且對提升統計風場的參考價值很有限。增加輸出資料的網格點和計算範圍見圖14。

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

松山機場RCSS

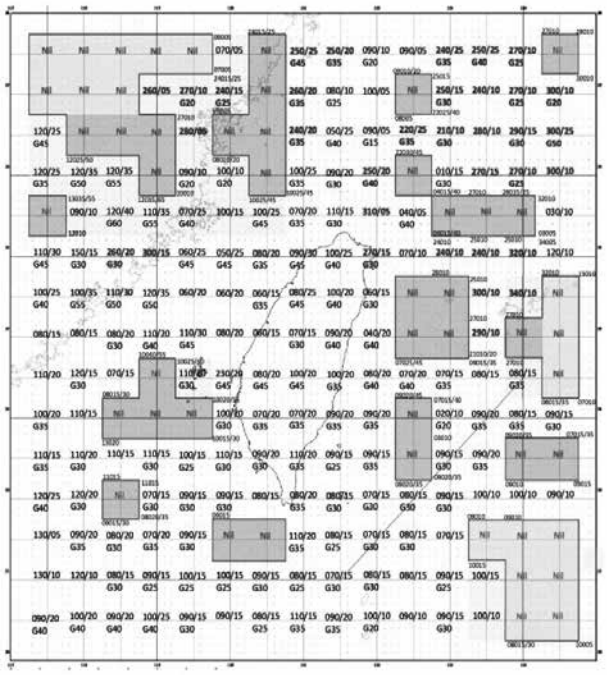


圖12：與圖3同為對應於輕度颱風中心位置之松山機場出現的風場。但加上經緯度各0.25度網格點的統計資料。增加的資料以小字體顯示。

1. **對無資料的NIL區無幫自助。**
2. **對統計風場的解析幫助不大，0.5度網格點的統計資料可涵蓋0.25度網格點的統計資料。**
3. **需花大量時間費處理資料，而效果不彰，因此不應用於所有機場。**

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。
2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。
3.統計資料自1958至2007年共238個颱風。童茂祥2014

對應於輕度颱風中心位置之民航機場出現的風場，輕度颱風中心最大風速34KT～63KT

定義：中心最大風速50KT(±10KT)　　中心氣壓985hPa(±10hPa)

統計範圍東西南北各0.25經緯度

北竿機場RCMT

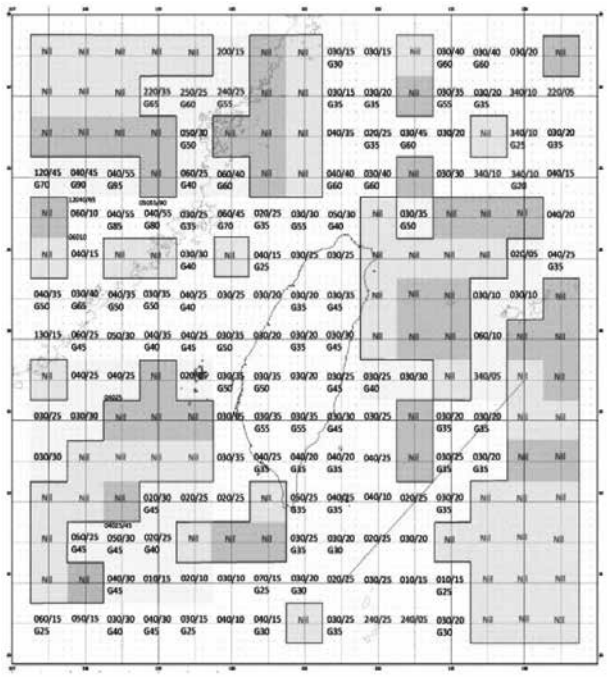


圖13：與圖8同為對應於輕度颱風中心位置之北竿機場出現的風場。但加上經緯度各0.25網格點的統計資料。增加的資料以小字體顯示。

1. **無資料的NIL區無幫自助。**
2. **對統計風場的解析幫助不大，0.5度網格點的統計資料可涵蓋0.25度網格點的統計資料。**
3. **需花大量時間費處理資料，而效果不彰，因此不應用於所有機場。**

1.Nil表示此點東西南北各0.25經緯度範圍內(藍色無紀錄資料、綠色無颱風通過資料)。
2.網格點資料選取最高平均風速與最大陣風，風向取頻率較高值。
3.統計資料自1958至2007年共238個颱風。童茂祥2014

圖14：增加的經緯度各0.25°格點和計算範圍

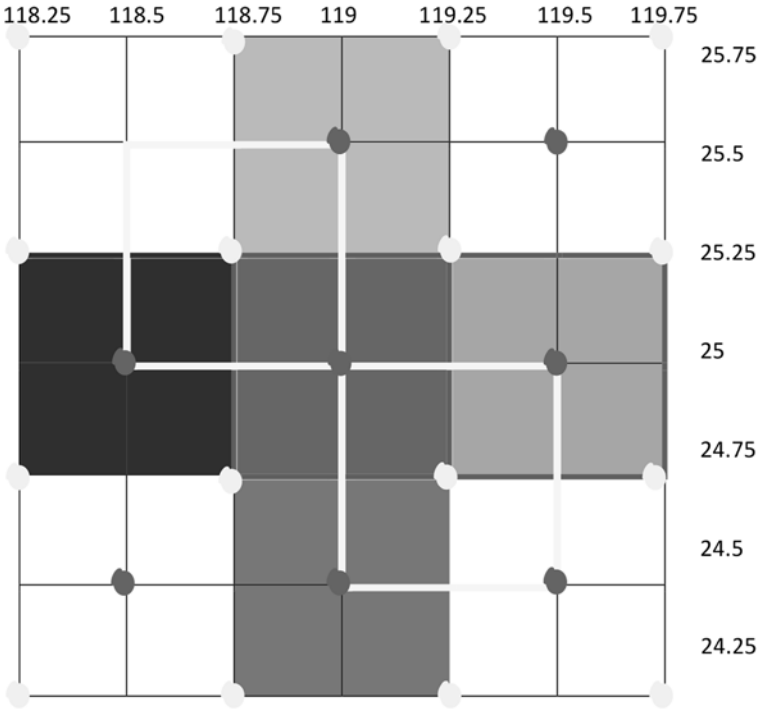


圖14中：

(一) 紅色實心圓點為圖3至圖11所使用的計算格點，也就是顯示的格點都在經度與緯度的0.0度或0.5度上。格點上的機場平均風速為四周經緯度各為0.25度之範圍內(填滿不同顏色區域)。

(二)黃色實心圓點為圖12與圖13上增加的計算格點，也就是格點位於0.25°或0.75°經緯度之上。格點上的機場平均風速為四周經緯度各為0.25度之範圍內(黃色線條圍成的區域)。

四、輕度颱風中心在各經緯度統計風場出現次數

在統計分析過程中發現颱風中心似乎在某些區域內出現的次數特別多，將颱風出現的次數填入網格點上並繪製等值區域，見圖15。圖中不同顏色的數值與區域的代表意義如下：

(一) 格點的上層數字是格點四周經緯度各為0.25度區域內，在颱風資料庫中找到颱風中心曾經出現在該區域內的定時天氣之總次數。但因颱風移動方向與速度快慢皆不同，所以出現總次數較多的區域，雖然不能絕對說颱風路徑經過該區域次數的要比別的區域多。但事實上，經仔細分析颱風路徑資料後，發現颱風路徑通過該區域的機會確實大很多。

(二) 格點的下層數字的定義與上層數字相同，唯一差別是次數的總合。上層數字為定時天氣次數。下層數字為定時天氣次數加上臨近上下15分內之特別天氣次數，因此會大於或等於上層數字，但因天氣劇烈變化會導致機場發布大量特別天氣的次數，因此與颱風路徑經過該區域次數的相關性較低。

(三) 格點上層的定時天氣次數之數值以不同顏色表示，0～5次為黑色，橘色為6～9次，10～19次則為紅色，20次以上為加粗橘色。

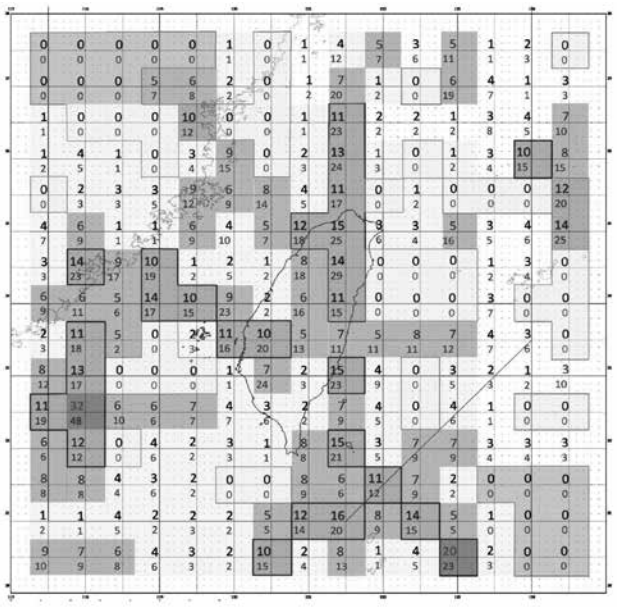
(四) 格點下層的定時天氣次數加上特別天氣次數之合計總數一律為藍色。

(五) 在格點四周各為0.25個經緯度之區塊，填滿紅色區塊為10次以上，5-9次為淺綠色，1-4次則為未填滿顏色的區塊。另外，0次四周的黃色區塊代表資料庫中皆為不符合條件，即颱風中心未曾出現的區域；0次四周的淺藍色區塊則可能為不符合條件、資料庫未記錄的區塊或已減弱為Td。

圖15：輕度颱風中心在0.5格點統計範圍內出現之次數

輕度颱風中心在各經緯度統計風場出現次數
輕度颱風中心最大風速34KT～63KT
定義：中心最大風速50KT(±10KT)
中心氣壓985hPa(±10hPa)
統計範圍東西南北各0.25經緯度

松山機場(RCSS)



五、結論

為能於颱風侵襲台灣期間符合航空公司需求，提供民用機場72小時或更長時間的風場預報，因而建立對應於颱風中心位置之民用機場出現的風場，供預報員參考使用。由於資料輸入費時且其效用有待測試，因此決定先行探討在輕度颱風侵襲台灣期間各民用機場的風場，獲得成果如下：

(一) 本研究於2014年8月完成，9月正好遇到輕度颱風鳳凰侵襲台灣，以本文的研究方法作出72小時民用機場的預報風場，然後與實際發生的風場互相比對，結果確實能夠反應風場的變化。

(二) 雖然研究成果受到肯定，但僅一次的驗證仍為不足，需再多接受幾次測試後才能確認其效用。然後再來評估是否值得將此研究延伸至中度颱風。

(三)研究過程中發現颱風中心出現在0.5格點統計範圍內的次數與颱風移動的路徑似乎有關聯性，是否可作為預報颱風移動的參考，值得加以探討。

(四)研究使用的資料庫自1958至2007年，距今已超過6年。雖然這6年中侵襲台灣的颱風次數並不多，此情況下，雖然對於風速的平均值影響不大。然而每一個颱風的移動路徑皆不同，對於過去颱風中心未曾經過的區域，應可以提供有效的參考，因此持續增加颱風資料庫的資料是必要的。

(五)在東風與西風轉換之區域，統計結果會出現兩個不同風向值，本文僅顯示頻率較高的風向。預報員作業時會考慮實際狀況，選定及標示合理的風向。

(六)網格點如位在中央山脈上，實際風場會更複雜，因此僅供參考。

(七)統計範圍內出現之次數為0次時，如四周為黃色區塊代表資料庫中無符合條件資料，即颱風中心未曾出現的區域；四周為淺藍色區塊則可能為無符合條件資料、資料庫未記錄的區塊或已減弱為Td。

(八)增加經緯度各0.25度網格點的統計資料，期望能有更多輸出資料可供參考。經比對後，發現對於Nil區域的資料增加有限，且對提升統計風場的參考價值很有限。

(九)當輕度颱風中心通過北竿機場，之後登陸大陸並移至北竿機場西北方時(119° E～118° E)，北竿機場出現45KT平均風速和95KT的陣風，而此刻大部分颱風強度都已減弱，甚至減弱為熱帶氣旋，但仍出現90KT以上的強陣風原因，主要是東北風的共伴效應及地形因素造成。

六、參考文獻

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The wind field of civil airport relative to the location of light Typhoon center

TUNG, MAO-SHIANG

ABSTRACT

The hazard of the Typhoons that invaded Taiwan, whose rainstorm and strong wind will cause flood and wind damage. Both of these facts not only cause the losing property, but also safe threat for us. In additional, it also makes the ground and air traffic system shutdown. It always makes the passengers inconvenient and loses large transport.

Before 2008, during the typhoon warning period, there are much less ideal and objective wind field data for the forecasters referencing. Now we usually depend on the forecast wind data from every meteorological unit, digital modeling value and the experience of the senior forecasters. However, they are not ideal enough.

In view of this, Taipei Aeronautical Meteorological Center (TAMC) finished「The wind statistics at the civil aeronautics airports during typhoon invades Taiwan」 research program and incorporated into the routine operating system in 2008. Then using this wind field search system to predict the maximum wind velocity, maximum gust and time series change of wind direction during the typhoon warning period. After compared to actual weather report, just only had a little deviation, confirmed that the system does seem to have a good reference value.

The purpose of this study is provides over 48 hours forecast wind field of civil airport for airline reference during the typhoon warning period. Make use of the wind field statistics system produced the wind field of civil airport relative to the location of light typhoon center in Aug. 2014. In Sep. the light typhoon Phoenix just invades Taiwan. As the typhoon approaches the sea of the Taiwan southern end, based on the future predicted path published by many country to produce 72hour time series of the forecast wind field. After the center of the typhoon track forecast was not ideal. But compared the actual wind field to statistics wind fields, found the actual gap is small and in terms of wind direction changes are available. Make sure that the wind field statistics could be a good reference. Simultaneously display the correct movements of typhoon track forecast, do take the wind field statistics function.

1. Foreword

During the typhoon hit Taiwan, the entirely and correctly forecasting of civil airport wind field is always been an important subject of TAMC. In a previous operation mainly rely on forecaster prediction of subjective experience. Because the Typhoon is not circular and does not take into account the influence of topographical factors, tends to forecast errors. Therefore, establishing an objective forecast data is essential.

Domestic meteorological operation units had using many years data during typhoon invades Taiwan, carefully analysis the flow field distribution of typhoon and each observation station, also the relationship with location of typhoon center to established up a 8 airflow field types. But, if carefully to read its research content, not difficult found for flow field analysis of scale just a general regional nature of statistics. The regional of range is big enough to cover whole west half part and small to can up a county city. So for the practical utility of meteorological operations of civil aviation, although it has the reference value, but it is not precise enough. Various civil airports still does not meet

expectations for wind field forecast.

For this reason, TAMC know that the original reference research results is not match the civil aviation meteorological realities, so why not set out to organize on their own during the typhoon invasion. All the situations affected by the typhoons of airports, in addition to improving weather observer and the cognition of wind characteristics, can effectively assist weather forecasters prepare typhoon warning with all kinds of aviation meteorological report. More may also be offered the airline as its operating reference policy.

In 2006 TAMC began gathering data and analyzing, then submitted the「The wind statistics at the civil aeronautics airports during typhoon invades Taiwan」research projects to CAA in2007 and completed by statistical analysis in May 2008. Then pass Bolaven (0802), Kameiji (0807) and Phoenix (0808) typhoon test from Jul. to Sep. in same year. In this period TAMC forecaster use this search systems to forecast the time series of 24hr maximum wind speeds and maximum gust. The forecasted wind field compared to actual weather report, just only quite difference. There is confirmed that the search system is a good reference for forecasting the wind field. Finally the study report is completed at the end of same year.

Then in 2011 TAMC submit another research projects「The implement and application of neural network wind analysis system for aviation aerodromes during typhoon invasion」and complete the study at the end of same year.

For the continuation of former research, TAMC use nonlinear regression characteristics of neural network and join the timeline input and interpolation functions in this research project, to establish a neural network wind analysis system for aviation aerodromes during typhoon invasion which can authenticate with typhoon wind field inquiry system and suits for meteorological practical use in operation. Many complicated calculations and input are simplified and automated, are hoping to help forecasters making effective and stable job during the typhoon approaching.

Followed in 2012 and 2013 during the typhoon hit Taiwan, forecasters used two complementary wind forecasting methods, the release correctly forecast the wind farm to provide the control, terminal and airlines reference received.

TAMC based on the service specifications for routine operations. Just they are issued a typhoon alert phase, will be available 48 hours of wind field forecast for airlines reference. But sometimes it is informed by the airline for more than 72 hours or more of wind field forecast demand. Although the forecast period has been far beyond the job specification, but in order to strengthen the aviation weather services, forecasters are still busy trying to meet the needs of airlines. Therefore, to enhance the efficiency and accuracy of provision of advance, to establish corresponding to typhoons wind field in the Centre of civil aviation airports, for long period forecast of reference. Therefore, in order to improve efficiency and provide forecasting accuracy, plans to establish the civil airports wind field correspond to the position of typhoon center and be a reference for a longer period of forecast.

2. Research methods

This paper calculated the average wind field is to “The wind statistics at the civil aeronautics airports during typhoon invades Taiwan” to extend the use of research results. Therefore need to mention the two perspectives of the study (For more information on this study, please refer to the 2008 CAA report), in order to understand the meaning of this article on behalf of the average wind field, as well as restrictions due to the raw data, there is no cause why those regions corresponding to the wind data from.

(1) Data processing

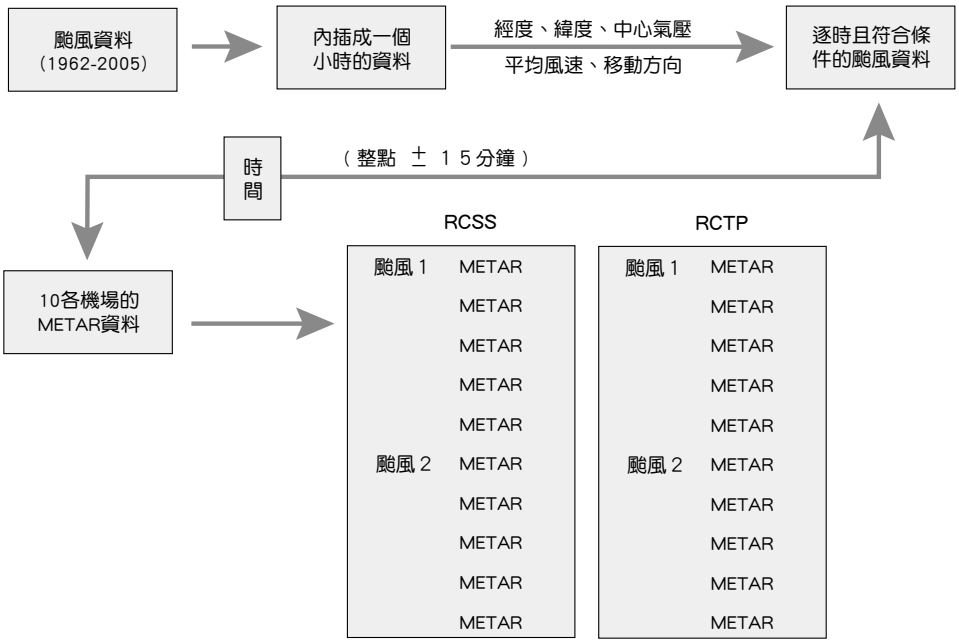
Uses two types of data: first one is 10 aeronautical meteorological observation station belongs year fixed timing METAR, the other one is from National Taiwan University Corporation for Atmospheric Research Database obtained in invading Taiwan typhoon data each year. Although during the invasion of Taiwan typhoon information is from 1958 to 2007 a total of 50 years, but because 10 aviation meteorological station was set up at different time, so when

comparing data for the individual, the late establishment of the observatory since the year compared with the covers short. We can imagine the number of data is bound to comply with its relatively small, but it may affect their statistical results.

Data processing is shown in Fig 1.

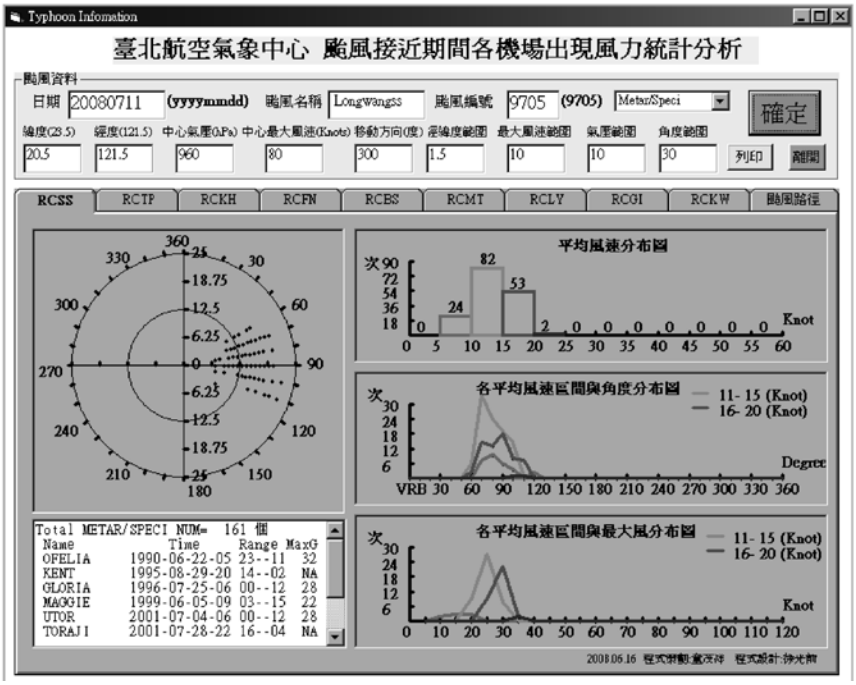
During a typhoon approaching, airport' wind field search and display layout shown in Fig 2.

Fig 1: data processing



(2) The search and display layout for wind field

Fig 2： Typhoon to search for and display layout



(3). Research steps：

A. Planning the density of input data for analysis and how to displayed the results

i Data sources of average wind: Database used in calculated average wind field as use of「The wind statistics at the civil aeronautics airports during typhoon invades Taiwan」research programs, from 1958 to 2007 a total of 238 typhoon information and typhoon wind field Search and display layout to display statistics.

ii Display a chart of the average wind field: For easy to read and display the representative wind field is set to the display format of Fig. 0.1 degrees of latitude and longitude of each grid point. If latitude and longitude are Integer, the grid lines as a solid line, 0.5 degrees as broken line and the remaining dots only.

iii Range of displays chart: Taking into account the scope of the database because of the restrictions meteorological center storage, and can meet the needs of more than 72 hours forecast, showing the range of the chart set at between longitude 27.5° N～20.5°N, latitude at 117.5°E～124.5° E.

iv Spacing of grid point: After each test, about 0.5 degree of latitude and longitude grid spacing is ideal. Grid spacing is too small not too time-consuming, and there is missing data are not included in the calculation. Grid spacing is too large, resulting in the phenomenon of information over double counting occurs. Around the grid covers the range of 0.25 degrees pitch enough to cover not only the data and not repeat the calculation time can be saved.

v Designates only the light typhoon first: Because the analysis process need to enter large amounts of data and statistical value judgments every point, it is a time-consuming job, another important point, I do not know whether its benefits can achieve the desired effect, so only first investigate the case of mild typhoon. After depending on user feedback, re-assess the need to extend to moderate typhoon.

B. layout definition of the input data:

i Central pressure: Maximum wind of light typhoon is between 34KT～64KT, take the middle value 50KT, and relative central pressure of about 985hPa

ii The maximum wind speed: 50KT

iii Direction of movement: 360°

iv Latitude/longitude range: Longitude and latitude are spaced 0.25°

v Maximum wind speed range:± 10KT

vi Pressure range:± 10hPa

vii Angle range:360°

C. Analysis the statistic wind field

Wind statistical results (see Figure 2) after entering data in typhoon wind field of search and display layout, the figure on the left to display all the information on the disk appear Wind Point, on the right are the average wind speed distribution, each average wind speed range and angle distribution of various the average wind speed range with maximum air distribution. To meet the needs of the average distribution, analyzing rules are as follows: Figure 2 of the cases. The typhoon center moved to 20.5 degrees of latitude and 121.5 of longitude, the number appears in the SS Airport wind direction are between t060° ~ 110°.But the wind is a vector, take the average is meaningless, select the highest frequency of 070° as a representative. Relative wind speed at 110KT ~ 20KT room, while the maximum gust up to 40KT. Therefore, the latitude and longitude of the wind field is marked as 070 / 20G40.

3. Statistical analysis of the results of wind field display (Figure 3 to 13)

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T～63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCSS Airport

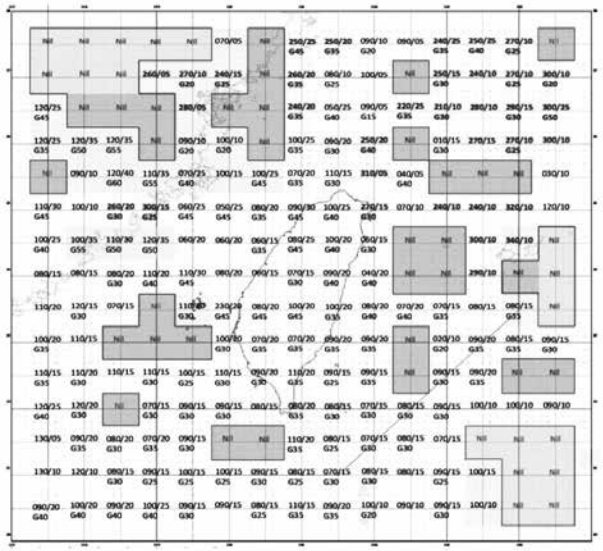


Fig 3: Wind field of RCSS airport corresponds to the location of light typhoon center.
(grid points are 1 and 0.5 degree of latitude and longitude).
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT~69KT yellow shaded representation.
Weather data for statistical including:06L ~ 24L: Hourly, half hourly and special observation data. 00L ~ 06L: hourly and special observation data (half hour do not operation)
4. Gusts> 70KT light red shaded representation.
RCSS Airport appears 50KT ~ 55KT strong gusts period, light typhoon arrives 119°E ~ 118°E, near 24°N ~ 26°N.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCTP Airport

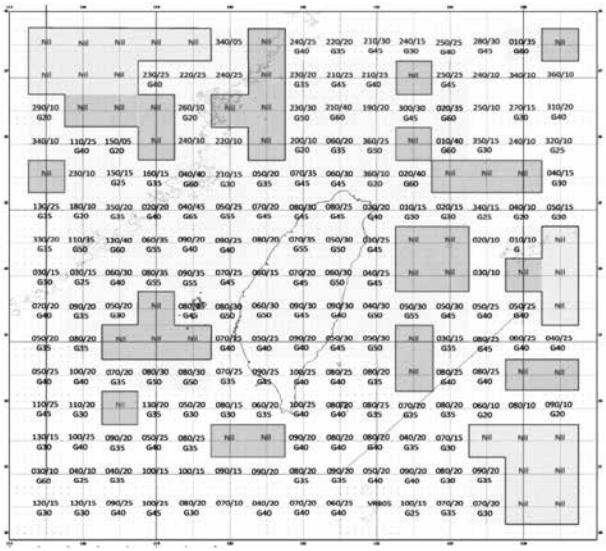


Fig 4: Wind field of RCTP airport corresponds to the location of light typhoon center.
Weather data for statistical including:
00L~24L: hourly, half hourly and special observation data
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
RCTP airport appear 50KT ~ 65KT strong gusts period, light typhoon before landing and leaving the land to move north and northeast of the sea.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCKH Airport

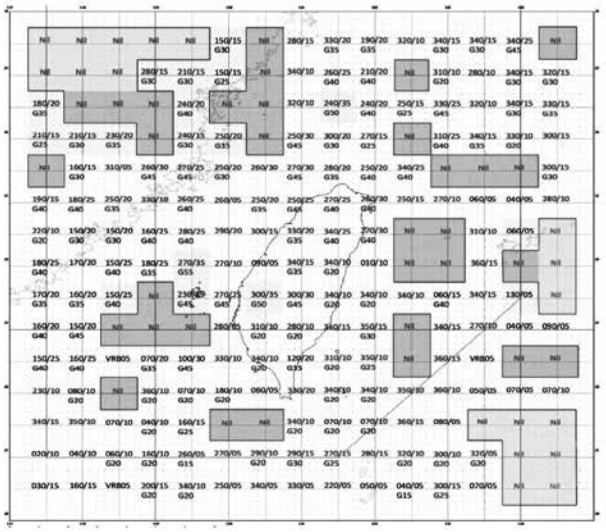


Fig 5: Wind field of RCKH airport corresponds to the location of light typhoon center.
Weather data for statistical including:
06L ~ 24L: Hourly, half hourly and special observation data 00L ~ 06L: hourly and special observation data (half hour don't operation)
1. westerly system (180° ~ 360°) in red font.
2. Easterly system (010° ~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
RCKH airport by the impact of the Central Mountain Range, therefore 50KT ~ 55KT strong gusts, will enhances when the center of the light typhoon near 24°N ~ 25°N.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCFN Airport

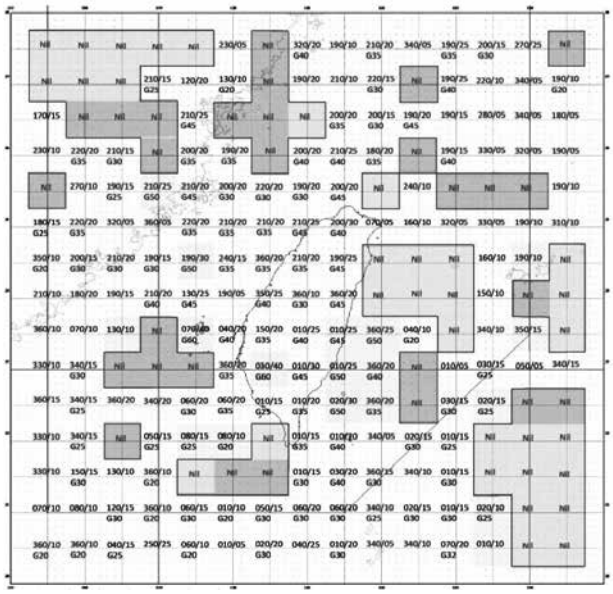


Fig 6: Wind field of RCFN airport corresponds to the location of light typhoon center. Weather data for statistical including:06L ~ 20L: Hourly, half hourly and special observation data(21L~05L don't operation)
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
RCFN airport by Taitung Rift Valley effects, so 50KT strong gusts will appear during in light typhoon appears in the eastern offshore; in addition, the typhoon appeared in southern onshore and offshore, it will appear the 60KT strong gusts.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCBS Airport

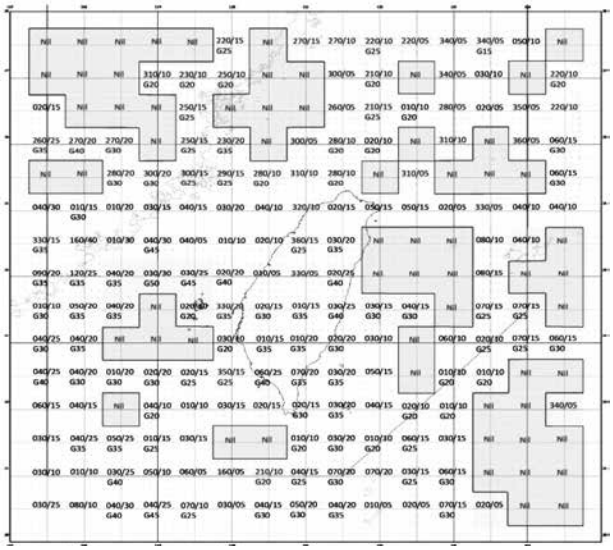


Fig 7: Wind field of RCBS airport corresponds to the location of light typhoon center.
Weather data for statistical including:
06L~20L: Hourly, half hourly and special observation data (21L~05L don't operation)
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT~69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
50KT strong gusts are appear when light typhoon near the area southeast RCBS and Offshore.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCMT Airport

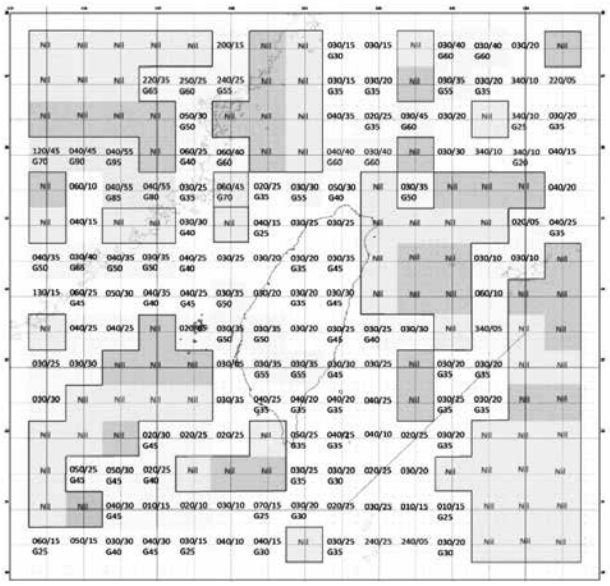


Fig 8: Wind field of RCMT airport corresponds to the location of light typhoon center.
Weather data for statistical including:
06L ~ 19L: Hourly and special observation data(half hour don't operation)
(20L~05L don't operation)
1.westerly system (180°~ 360°) in red font.
2.Easterly system (010°~ 170°) in black font.
3.Gust 50KT ~ 69KT yellow shaded representation.
4.Gusts> 70KT light red shaded representation.
When light typhoon center appear in the south of the RCMT airport, the RCMT airport appear 50KT~65KT strong gusts; In addition, when the typhoon center appeared in northeastern offshore of Taiwan is also the same situation. As the typhoon moved to west area of RCMT Airport, RCMT airport appears 70KT ~ 90KT strong gusts.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCLY Airport

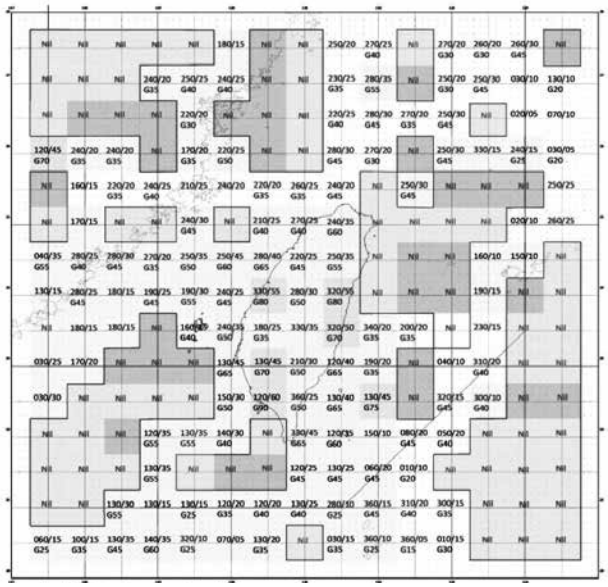


Fig 9: Wind field of RCLY airport corresponds to the location of light typhoon center.
Weather data for statistical including:
07L ~ 17L: Hourly and special observation data (half hour don't operation)
(18L~06L don't operation)
1. westerly system (180° ~ 360°) in red font.
2. Easterly system (010° ~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
When light typhoon approaching RCLY Airport and landing in the eastern part of the Taiwan, RCLY Airport appears 75KT ~ 80KT strong gusts; In addition, landing the south part of Taiwan, RCLY Airport has appeared more strong gusts (70KT ~ 90KT). Such as typhoon center moved to the northern part of the Taiwan Strait, RCLY Airport will also have strong gusts 50KT ~ 65KT.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCGI Airport

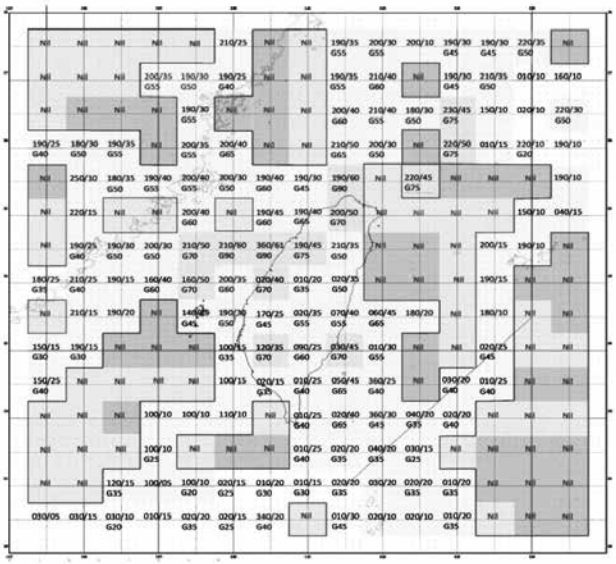


Fig 10: Wind field of RCGI airport corresponds to the location of light typhoon center.
Weather data for statistical including:
07L ~ 17L: Hourly and special observation data (half hour don't operation)
(18L~06L don't operation)
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
When light typhoon center near the RCGI airport and landing at the southern part of Taiwan, RCGI Airport appear 75KT ~ 80KT strong gusts; In addition, the typhoon center at north part of Taiwan and at the west of the Strait, RCGI Airport appear 70KT ~ 90KT strong gusts. As the typhoon moved within a vast area off the coast north of Taiwan, RCGI Airport appear 50KT ~ 65KT strong gusts.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCKW Airport

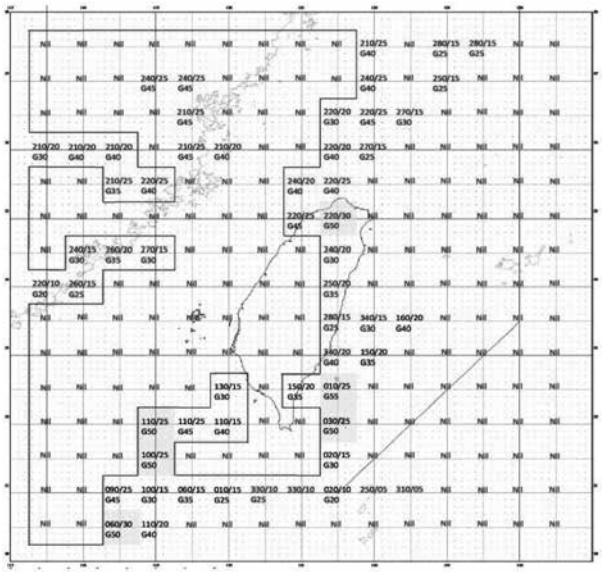


Fig 11: Wind field of RCKW airport corresponds to the location of light typhoon center.
Weather data for statistical including:
11L ~ 17L: Hourly and special observation data (half hour don't operation)
(18L~10L don't operation)
1. westerly system (180°~ 360°) in red font.
2. Easterly system (010°~ 170°) in black font.
3. Gust 50KT ~ 69KT yellow shaded representation.
4. Gusts> 70KT light red shaded representation.
RCKW Airport although only have little information, but limited information can still be seen when lightly typhoon center around RCGI airport and at the coast of Taiwan, RCKW Airport appears 50KT ~ 55KT strong gusts.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCSS Airport

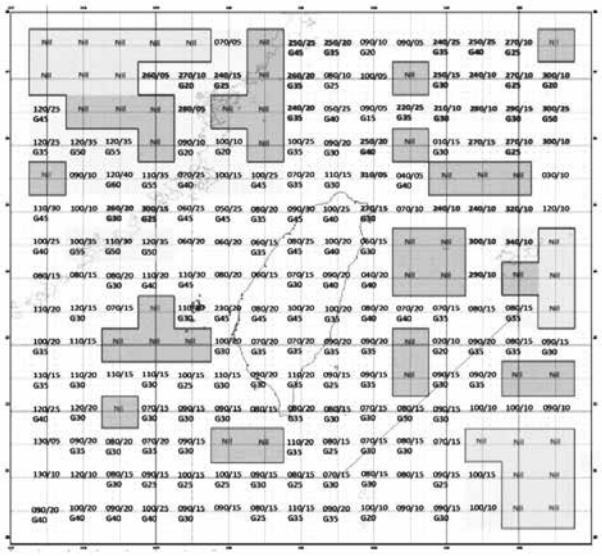


Fig 12: Same with Fig 3 is the wind field of RCSS Airport corresponding to the position the center of the light typhoon. But statistical data add the data form 0.25°grid point.
Additional information is displayed in a small font.
1. No information NIL area without help themselves.
2. The statistics help resolve little wind.
3. The need to spend a lot of time fee processing information, and ineffective, and therefore does not apply to all airports.

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)
2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value
3.The statistics from 1958 to 2007 a total of 238 typhoons

The wind field of civil airport relative to the location of light Typhoon center The maximum wind speed range of moderate typhoon: 34T ～ 63KT

Definition：the maximum wind speed: 50KT (± 10KT)　　Central pressure: 985hPa (± 10hPa)

Area of statistics is around 0.25 degrees of longitude and latitude

RCMT Airport

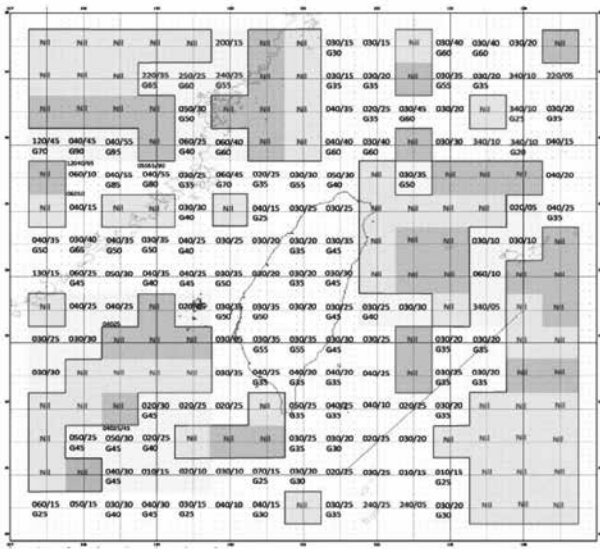


Fig 13: Same with Fig 8 is the wind field of RCMT Airport corresponding to the position the center of the light typhoon. But statistical data add the data form 0.25°grid point.

Additional information is displayed in a small font.

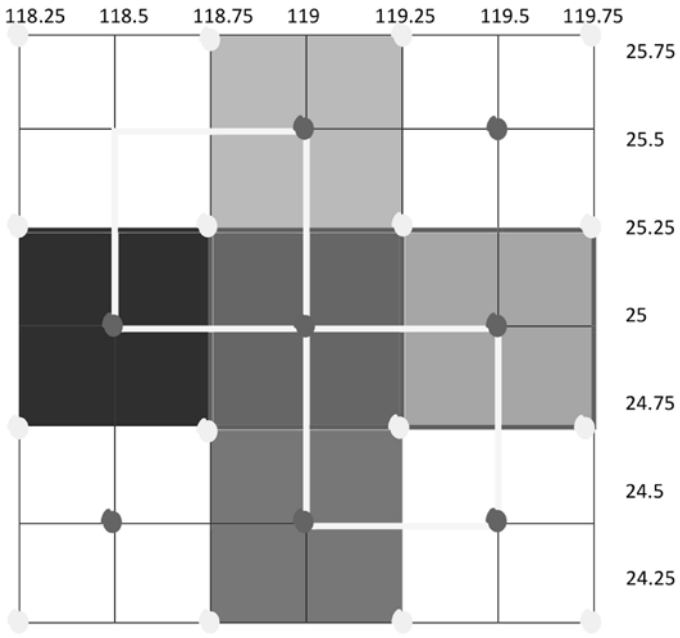
1. **No information NIL area without help themselves.**
2. **The statistics help resolve little wind.**
3. **The need to spend a lot of time fee processing information, and ineffective, and therefore does not apply to all airports.**

1.Nil expressed in this point of East and West longitude and latitude by 0.25 range (blue no discipline recorded information, no typhoon by green data)

2.Select the grid point data the highest average wind speed and maximum gust Take wind direction frequency of a higher value

3.The statistics from 1958 to 2007 a total of 238 typhoons

14：Increasing grid points and the calculation range



(A)Solid red dot grid points used for the calculation of Fig 3 to Fig 11, a grid is displayed on the latitude and longitude in degrees of 0.0 or 0.5 degrees. The average wind speed of airport on the grid points is within the range of 0.25 degrees average (fill different color regions).

(B)Solid yellow dot on Fig 12 and Fig 13 are the increased computing grid, which is located on grid points 0.75°or 0.25° latitude and longitude. The average wind speed of airport on the grid points is within the range of 0.25 degrees average (yellow lines enclosed area).

4. Times of typhoon center appear in the range that for wind field statistics

During statistical analysis found that the occurrences number of the typhoon center seems in some regions particularly, will fill the number of typhoons appear on the same grid points and draw the equivalent area, shown in Figure 15. Representing the value and meaning of different color regions on this Fig as follows:

(1) From The upper number of grid points around the latitude and longitude of each grid point is within 0.25 degrees area, find the center of the typhoon had appeared in the total number of METAR in the region. But every typhoon moving direction and speed are different, so the total number of more areas appear cannot absolutely say that the number of typhoon path through the region more than other region. But in fact, after careful analysis of the typhoon path data and found that the typhoon path through the region the opportunity to do a lot larger.

(2) The definition of the lower number of grid points is same as the upper number and only one difference is the sum of METAR and SPECI. Therefore, the lower number will be greater than or equal to the upper number. But the weather can cause dramatic changes in weather airport released a large number of special times, so the correlation with the typhoon path through the region the number is low.

(3) The amount of upper grid are represented by different colors, from 0 to 5 times as black, orange 6 to 9, 10 to 19 as red and more than 20 times as bold orange.

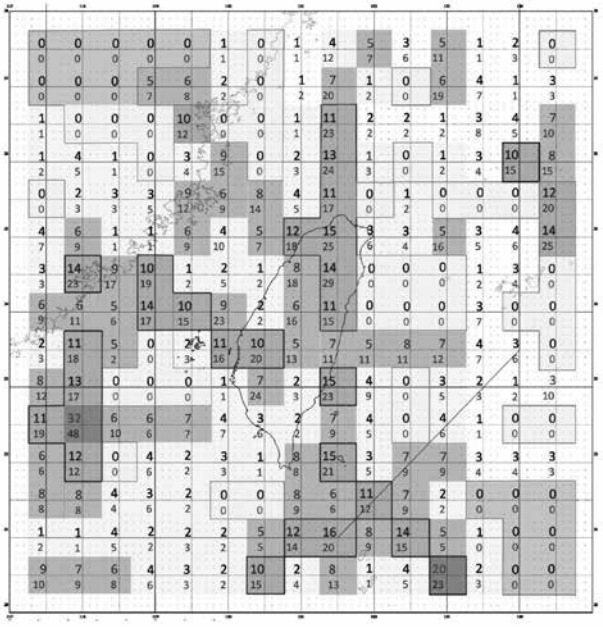
(4) Lattice lower number of weather plus totals are the total of the number of special weather for blue.

(5) The color of all lower number is blue.

(6) The block around each grid point by 0.25 degrees of latitude and longitude, fill the red block is more than 10 times, 5-9 times as light green, 1 to 4 times compared with blocks of color are not filled. In addition, 0 times block as yellow blocks is all representatives of the database does not meet the condition, blue blocks is not meet the conditions or database unrecorded block, whether it is the regional center of the typhoon had not appeared to be confirmed.

Fig 15: Times of light typhoon center appear in the range that for wind field statistics

The statistics numbers of light typhoon center appear in grid within the range of 0.5 degree of latitude and longitude.



5. Conclusion

To be able to meet the airline needs during the typhoon hit Taiwan, providing civilian airport 72 hours or longer wind forecasts, intends to establish a wind field of civilian airport corresponding to the position of typhoon center. But it will cost a lot of time and its effectiveness remains to be tested, so decided only to explore light typhoon first, to achieve results is as follows:

(1) This study was, completed in August 2014, just encountered mild typhoon Phoenix invasion station in September. Use the method of this study to made 72 hour forecast wind field of civil airports, then compared to actual to wind field. The results can really reflect the changes wind field.

(2) Although the results of this research be sure, but only once the verification is still insufficient, the need to accept more. Then evaluate whether it is worth extension to moderate typhoon.

(3) During this study found between the times of typhoon center appears in the statistical range of 0.5 grid point and move path of typhoon seems to have some relevance, whether it can be used as a reference forecast typhoon worth to be explored.

(4) Database used in the study since 1958 to 2007, now has more than 6 years. Although the number of typhoons hit Taiwan in 6 years is not much, although the average wind speed for little effect. However, the moving path of each typhoon is different, so to the area that typhoon center never been past should be able to provide an effective reference. Therefore, continued to increase the database of typhoon is necessary.

(5) In the area east and westerly conversion, statistical results will be two different wind values, the paper shows only the higher frequency wind. Forecasters will consider the actual situation when the job is selected and marked a reasonable wind.

(6) Grid points as in the central mountains, the actual wind farm will be more complicated so for reference purposes only.

(7) The number of occurrences within the statistical range of 0 times, the area surrounded by yellow blocks as the representative of the repository without qualifying information that has not appeared in the typhoon center; surrounded by a light blue block you may not qualify for such information, data library unrecorded block or weaken as Td.

(8) Increased by 0.25 degrees of latitude and longitude statistics grid point, we expect to have more output information is available. After comparison and found an increase in the area of information Nil limited and valuable statistics to enhance wind farm is very limited.

(9) When light typhoon center through RCMT airport and landing the mainland, after moved to northwest area of RCMT airport (119° E～118° E), RCMT airport appear 45KT average wind speed and 95KT gusts. At the moment, most of typhoons are weaken, even weakened into a tropical cyclone, but still appear strong gusts 90KT or more, mainly caused by common factors associated with effects of terrain and northeast wind.

6. References

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