

# 暖季弱綜觀條件下台灣中部午後對流特徵研究

**A Study of the characteristics of Afternoon Convection of Central Taiwan under the Weak Synoptic Condition in the Warm Season**

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# Outline

- Introduction
- Data
- Methodology
- Result
- Conclusion
- Future work
- Reference



# Introduction

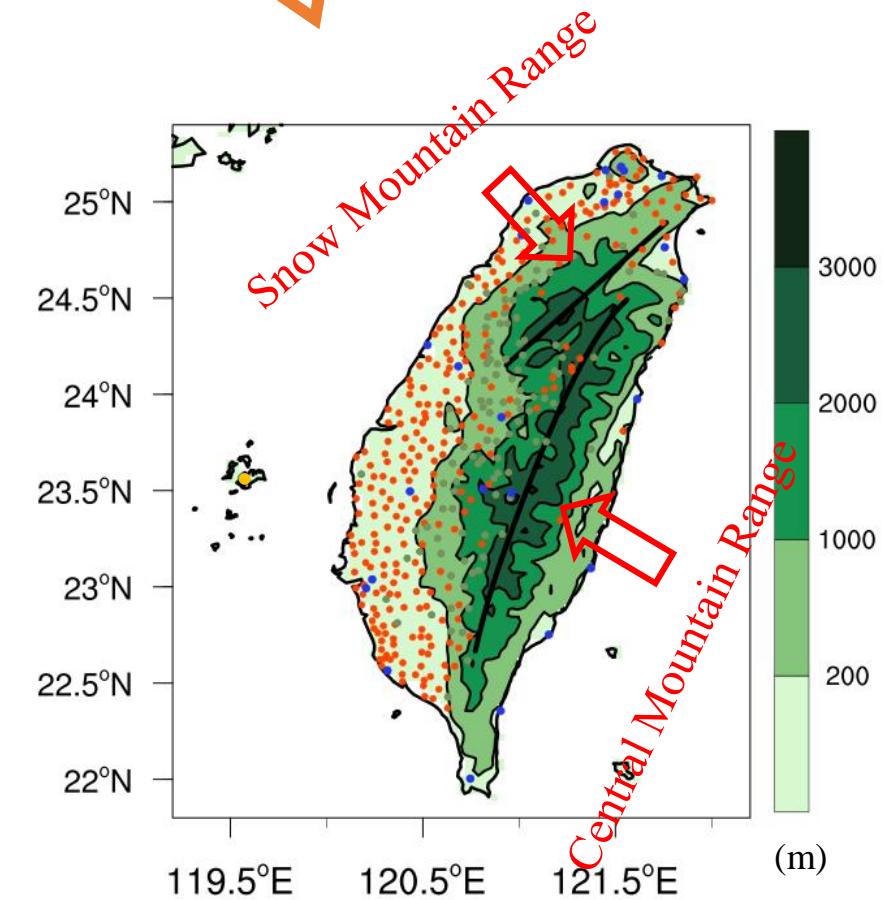
- Wang and Chen (2008)研究中，弱綜觀下的午後對流為暖季降水的主要供應者之一，也為台灣水資源的重要來源，但由於午後對流短延時強降水的特性，其伴隨的劇烈降水、雷擊、強陣風等事件，容易形成災害，對民眾的生命財產造成威脅。
- Lin et al. (2012)與Chen et al. (2016)針對台灣北部盆地區域的午後對流研究，由統計分析的方式，探討弱綜觀天氣形態下有無午後對流日的對流前環境差異，尋找午後對流前的環境徵兆，並分析午後對流的特性，對未來發展台北盆地午後對流的預報系統奠定基礎。
- 楊(2000)與Chen et al. (2014)的研究中發現，盛行風與降水位置之間有明顯的相關性，地形效應、局部海陸風環流、水氣條件都會導致降水的強度、分布位置及持續時間產生差異。
- Lin et al. (2011)分析台灣北中南東四區的午後對流的結果中，不同區域的午後對流特性不同，北部區域午後熱對流肇始時間較早，而中部與南部區域的午後熱對流較其他區域為劇烈且發展時間也較長，東北部的平均降雨時間則最短。
- 中部區域除了有較劇烈的午後對流發生，高度往東緩緩逐漸增加的地形，也是本研究選取中部區域分析的原因之一。
- 本研究主要以統計的方式，針對近年來暖季弱綜觀下台灣中部區域的午後對流，分析有無午後對流的對流前環境特徵，並找出可用來做預報的環境因子。

# Data

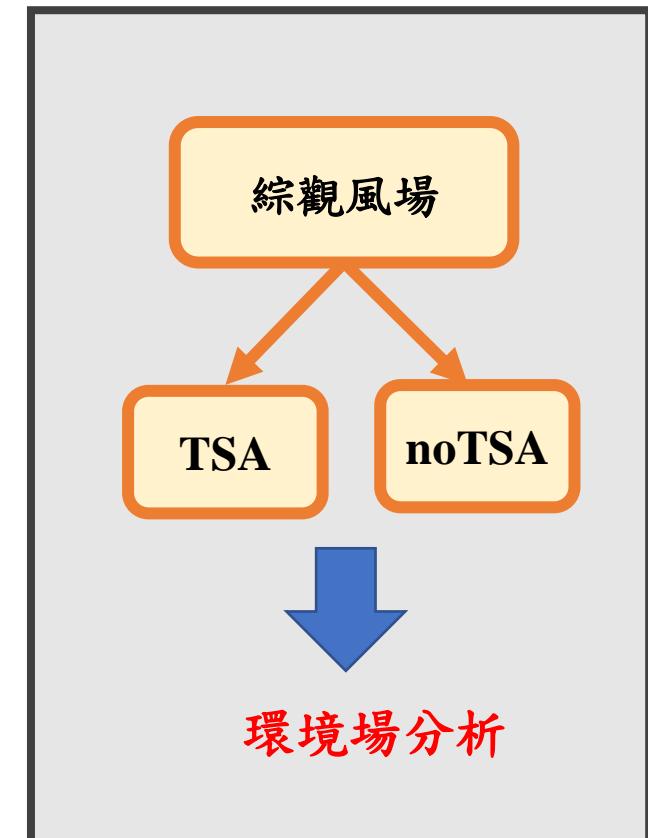
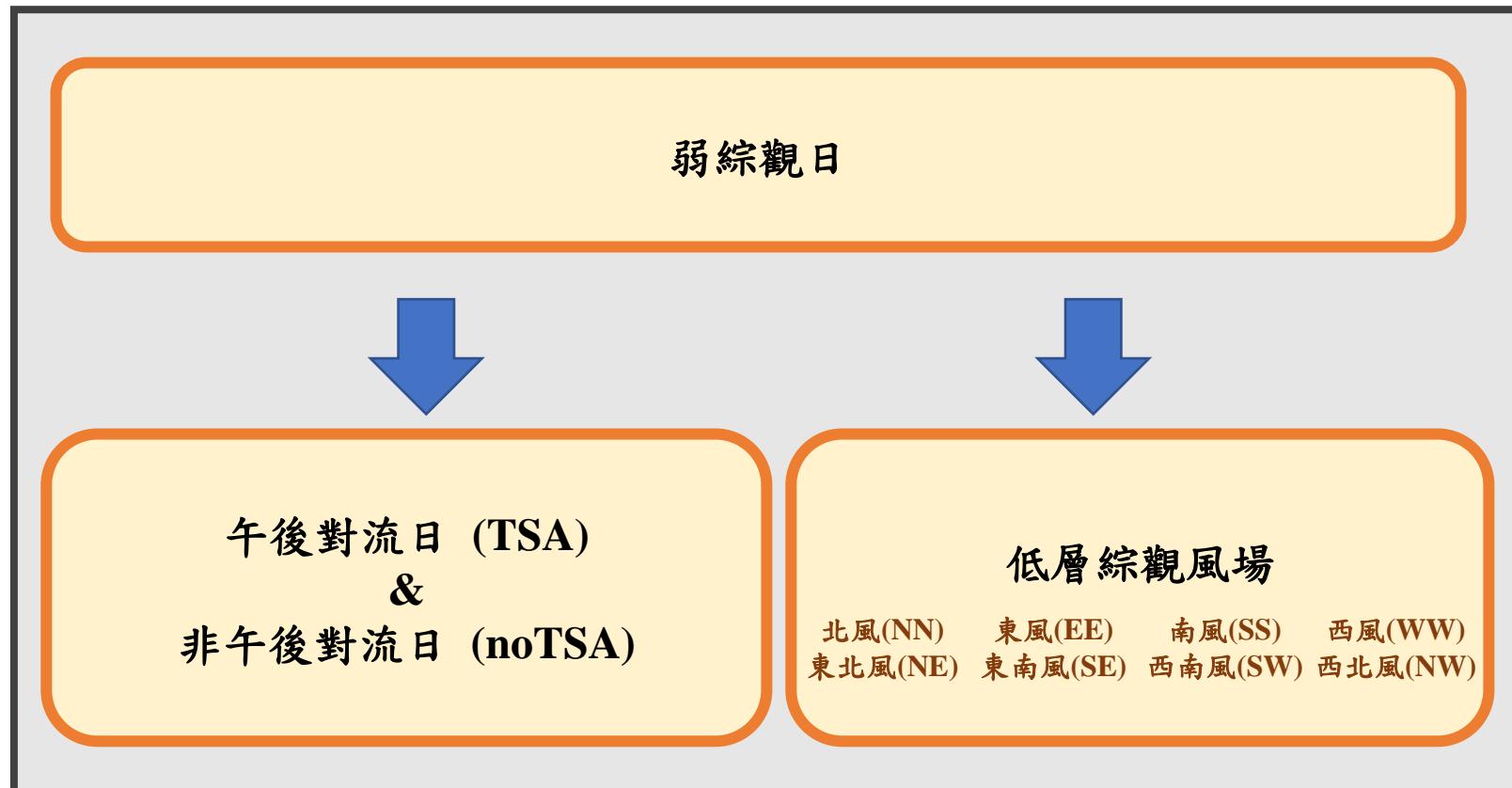
- 時間：2016-2020 年（暖季 05-09 月）
- 中央氣象局地面觀測站（時間解析度 1 小時）
- 馬公站探空資料 (00UTC)
- 歐洲氣象中心提供的 ERA5 的再分析資料  
(00UTC, 空間解析度  $0.25^\circ \times 0.25^\circ$ )

Total 410 stations

- : Bureau station
- : Automatic station
- : Rainfall station
- : Sounding station



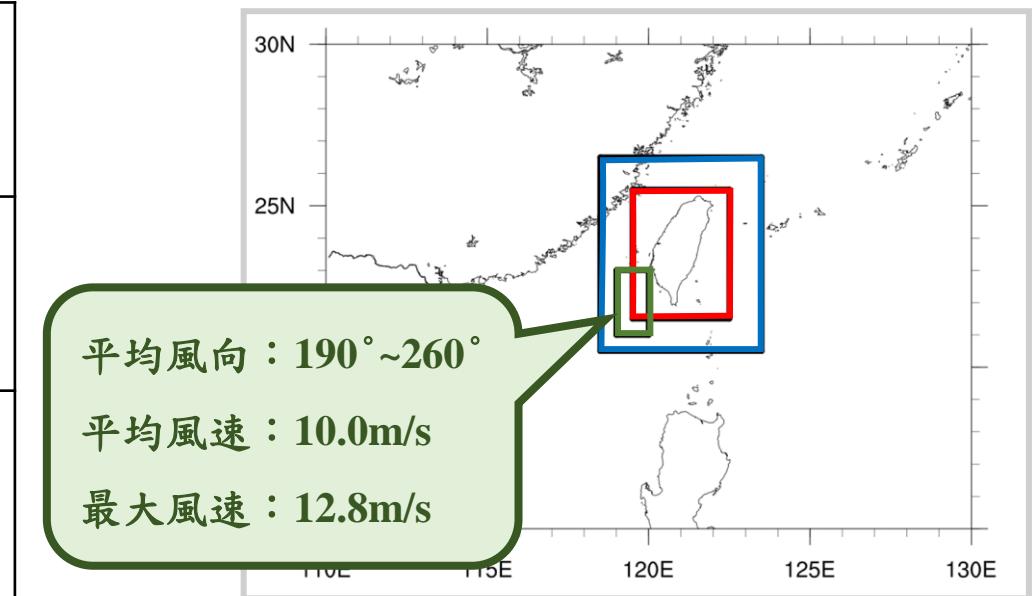
# Methodology



# Methodology – Weak synoptic

- 使用中央氣象局的地面天氣圖與ERA5再分析資料濾除綜觀系統日

|              |                            |  |
|--------------|----------------------------|--|
| 綜觀環境<br>濾除條件 | 鋒面<br>Lin et al. (2012)    | (0.5°)<br>21.5 – 25.5 °N<br>119.5 – 122.5 °E |
|              | 低壓系統<br>Chen et al. (2016) | (1.5°)<br>20.5 – 26.5 °N<br>118.5 – 123.5 °E |
|              | 西南氣流<br>朱(2017)            | (850hPa)<br>21 – 23 °N<br>119 – 120 °E       |



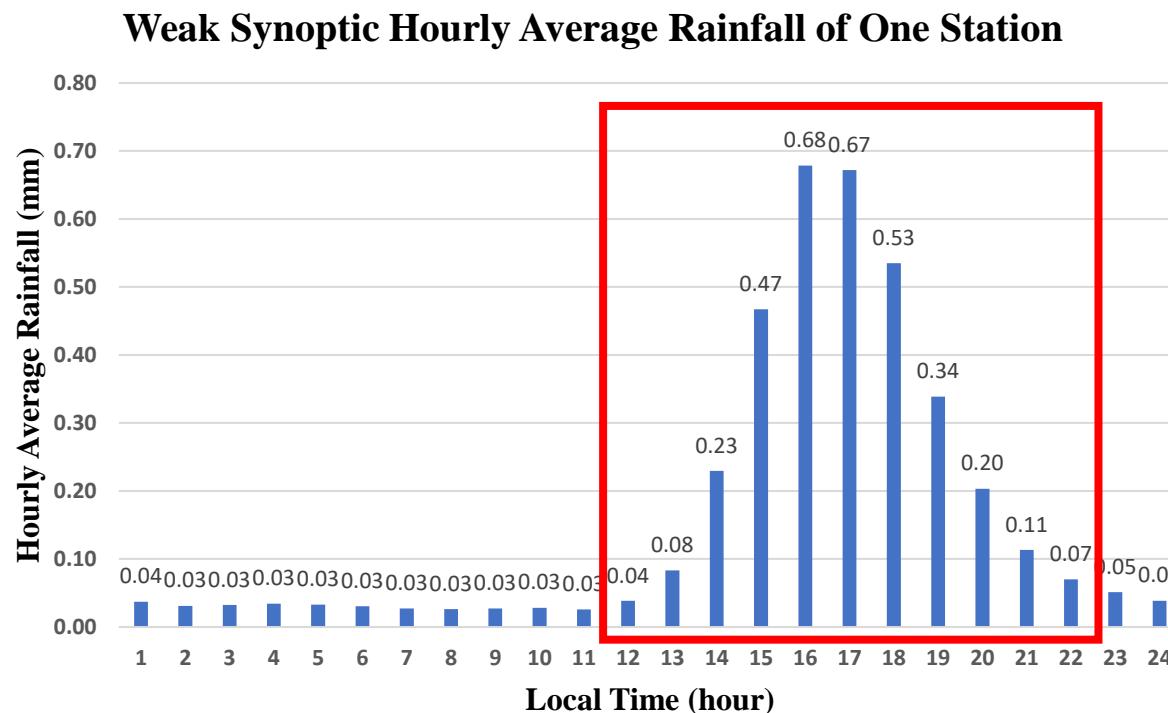
- 檢查濾完的弱綜觀日  
(Radar reflectivity 、 Infrared cloud image)



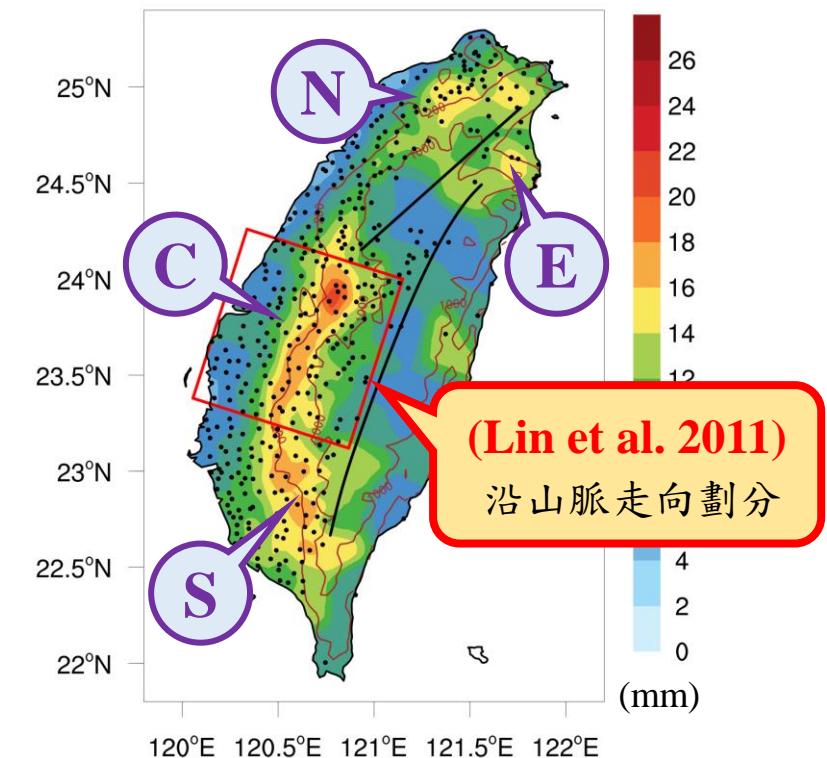
弱綜觀日：395 天

# Methodology – Weak synoptic

- Wang and Chen (2008)研究中，得知午後對流為弱綜觀中最強的降水事件，了解弱綜觀期間日平均降水的時空分布，有助於找出午後對流降水區。



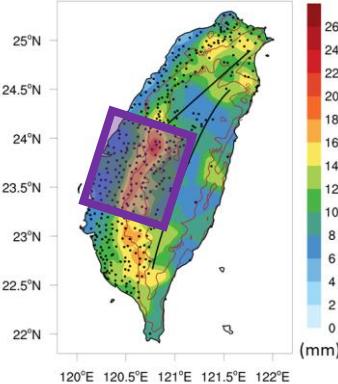
**weak synoptic average daily precipitation**



- 時間分布主要為午後
- 降水主要分為四區，並且多落在山脈的西側，於200~1000公尺的斜坡，地形凹槽處則出現極值
- 空間分布與Lin et al. (2011)弱綜觀期間之降水及林(1996)與張(1997)午後對流降水分布結果相似

# Methodology – TSA and noTSA

weak synoptic average daily precipitation



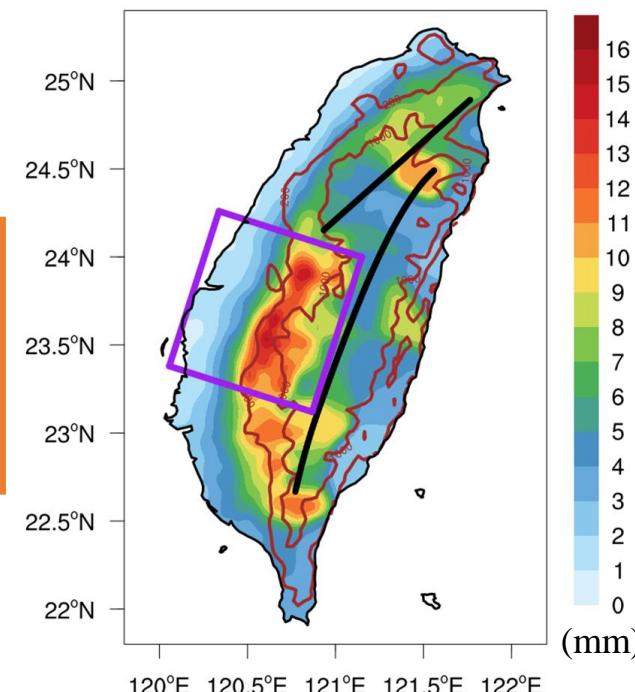
395 天的弱綜觀日

午後對流日 (TSA)

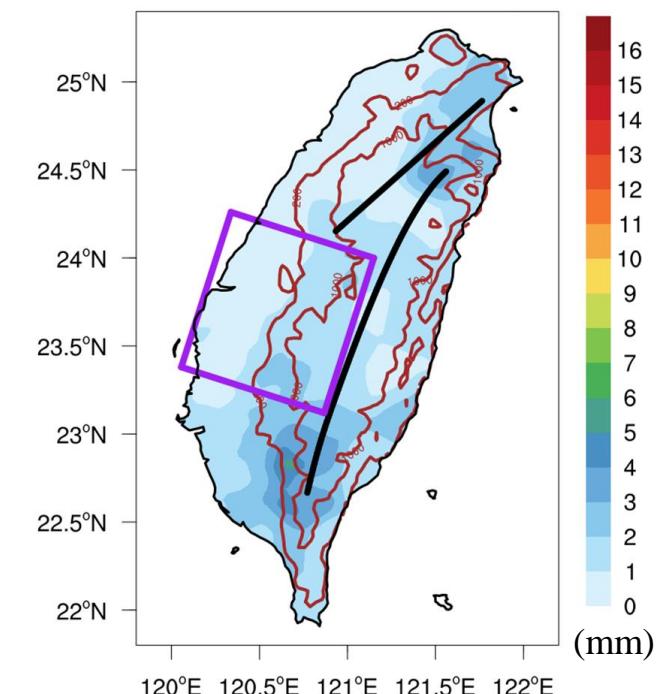
非午後對流日 (noTSA)

- TSA的空間分布結果與弱綜觀期間的降水分布類似
- noTSA並非完全沒有降水發生

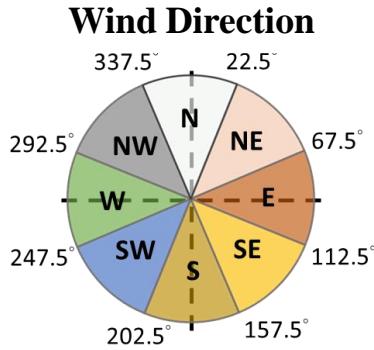
TSA Daily Average Precipitation



noTSA Daily Average Precipitation

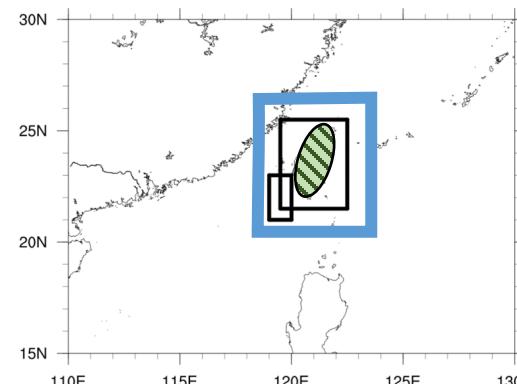


# Methodology – Synoptic wind field

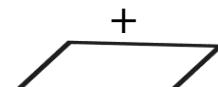


## PART 1 : 取平均風場

取 $1.5^\circ$ 範圍並率除地  
形上空的格點資料



925~1000hPa

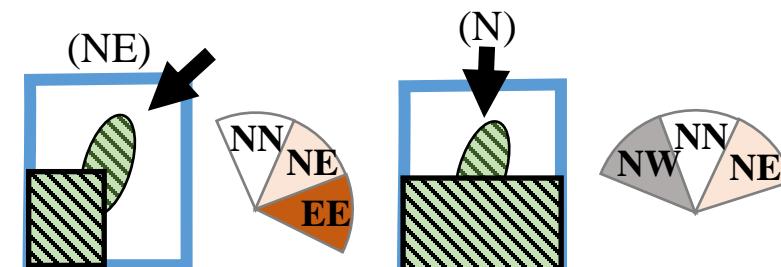


low level average

→ 平均風向風速

## PART 2 : 取各層風向

濾除背風側資料  
取最接近平均風向的三個風向進  
行水平方向上風向的頻率統計



→ 取有最大頻率的風向作為該層場之  
風向

Not Found : OTHER

## PART 3 : 取當日綜觀風向

取低層與平均場的最高頻率  
風向再做一次頻率統計

→ 取出現次數最多的風向作為當  
日的綜觀風向

→ 檢查平均風速弱 & OTHER &  
最大頻率值低

395 天的弱綜觀日

↓  
NN, NE, EE, SE, SS, SW, WW,  
NW, OTHER

# Methodology – Low level wind field

| Background Wind Cases | May |       |       | Jun |       |       | Jul |       |       | Aug |       |       | Sep |       |       | ALL |       |       |
|-----------------------|-----|-------|-------|-----|-------|-------|-----|-------|-------|-----|-------|-------|-----|-------|-------|-----|-------|-------|
|                       | TSA | noTSA | Total |
| NN                    | -   | -     | -     | -   | -     | -     | 1   | -     | 1     | 1   | -     | 1     | -   | 5     | 5     | 1   | 5     | 6     |
| NE                    | 5   | 6     | 11    | 1   | -     | 1     | 11  | -     | 11    | 10  | 5     | 15    | 8   | 24    | 32    | 25  | 35    | 60    |
| EE                    | 6   | 6     | 12    | 3   | 2     | 5     | 23  | 2     | 25    | 15  | 4     | 19    | 11  | 8     | 19    | 46  | 22    | 68    |
| SE                    | 6   | 10    | 16    | 20  | 3     | 23    | 10  | 2     | 12    | 6   | 3     | 9     | 5   | 6     | 11    | 60  | 24    | 84    |
| SS                    | 3   | 8     | 11    | 18  | 1     | 19    | 17  | 4     | 21    | 3   | -     | 3     | 3   | 1     | 4     | 37  | 14    | 51    |
| SW                    | 3   | 13    | 16    | 11  | 20    | 31    | 4   | 11    | 15    | 8   | 9     | 17    | 3   | 2     | 5     | 42  | 55    | 97    |
| WW                    | 2   | 3     | 5     | 3   | 1     | 4     | 2   | 1     | 3     | 1   | 2     | 3     | 1   | 1     | 2     | 11  | 8     | 19    |
| NW                    | -   | -     | -     | -   | -     | -     | -   | 1     | 1     | -   | 1     | 1     | -   | -     | -     | -   | 2     | 2     |
| OTHER                 | 1   | 1     | 2     | -   | -     | -     | -   | -     | -     | 1   | 2     | 3     | 1   | -     | 1     | 5   | 3     | 8     |
| ALL                   | 26  | 47    | 73    | 56  | 27    | 83    | 68  | 21    | 89    | 45  | 26    | 71    | 32  | 47    | 79    | 227 | 168   | 395   |

91%

- TSA天數：SE > EE > SW > SS > NE

- 與noTSA相比，僅在NE與SW的情況下noTSA較多

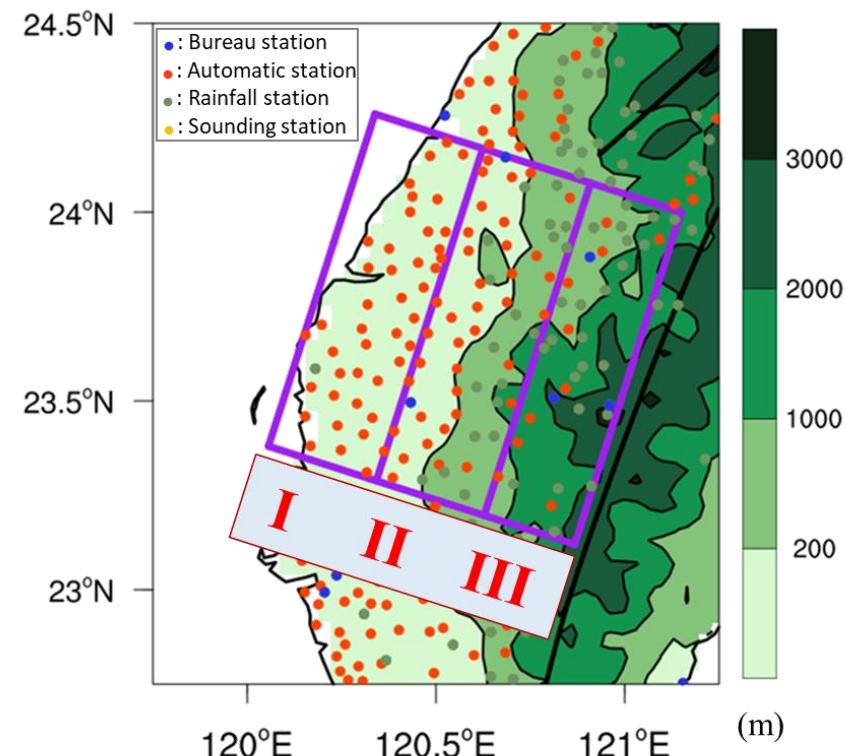
七月份受綜觀天氣系統影響最少，且發生午後對流的天數最多，與 Lin et al. (2011) 的統計結果類似

# Methodology

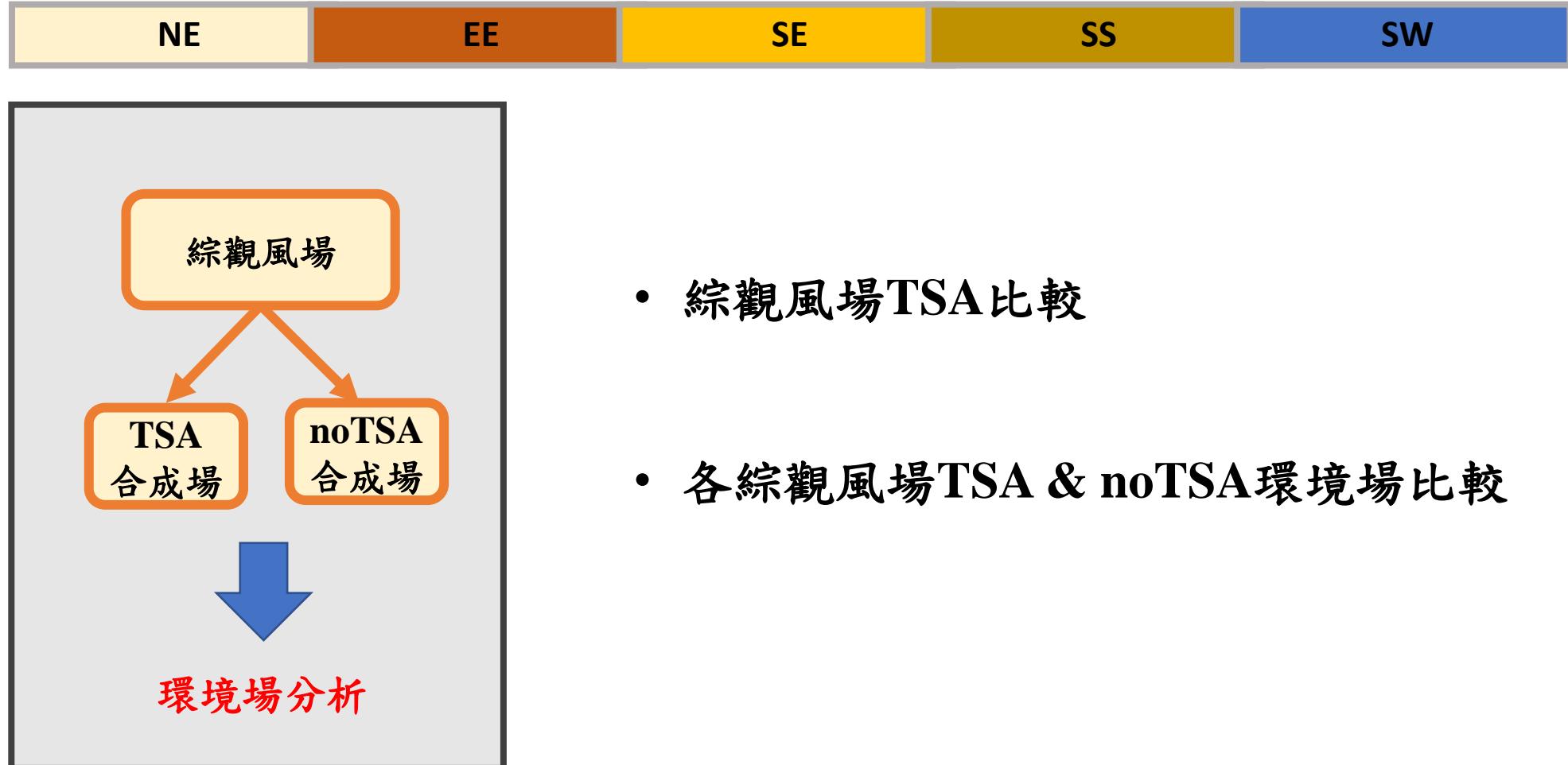
- 綜觀場分析 (00UTC) → 高低層配置，討論環境差異原因
- 探空分析 (00UTC) → 垂直環境場差異 & 穩定度差異
- 地表環境分析 (時序) → 降水與海陸風條件帶來的影響

分三區討論

| 名稱        | 沿海 (I)    | 斜坡 (II)     | 山區 (III)     |
|-----------|-----------|-------------|--------------|
| 與海岸間距     | 0 °~0.3 ° | 0.3 °~0.6 ° | 0.6 °~0.85 ° |
| 平均測站高度(m) | 29.4      | 384.3       | 1371.6       |
| 局屬站       | 0         | 2           | 3            |
| 自動站       | 43        | 37          | 10           |
| 雨量站       | 1         | 19          | 23           |

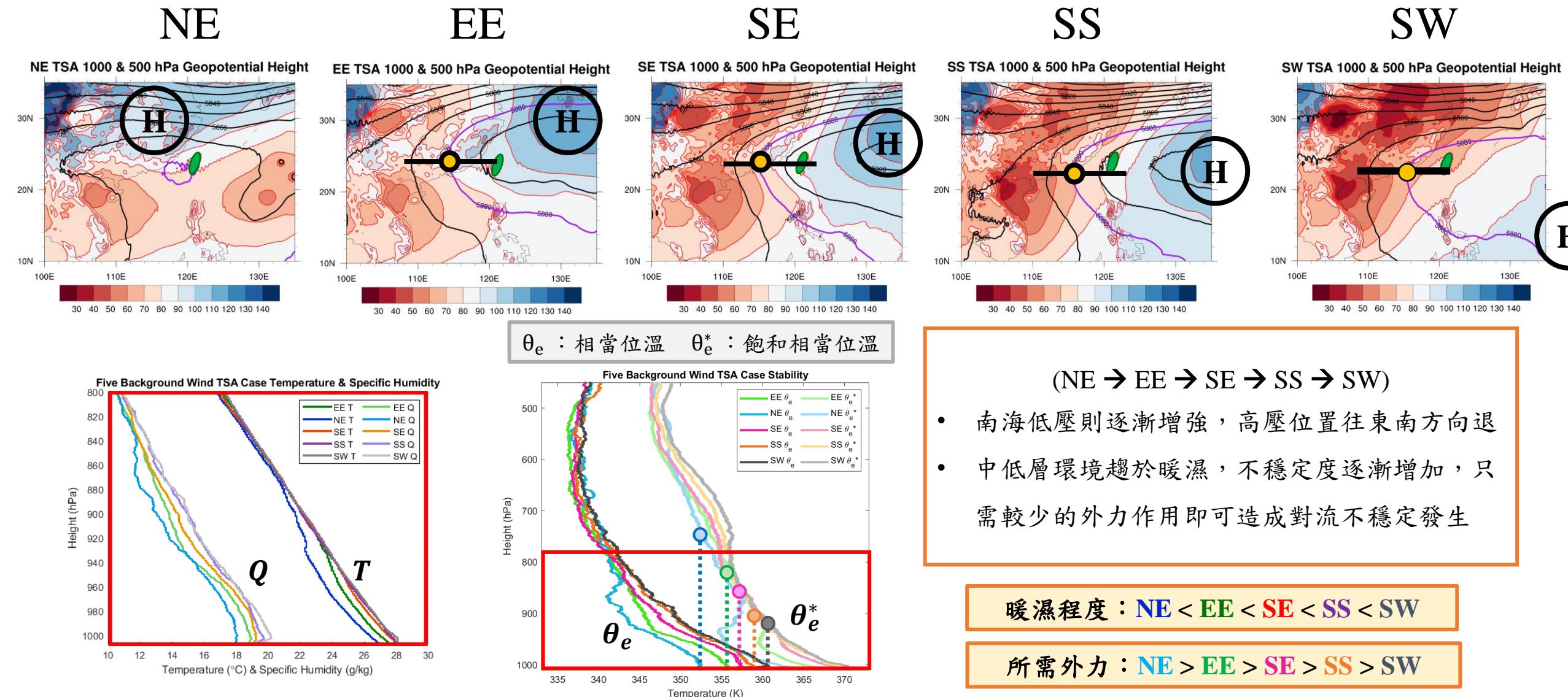


# Result – Environmental analysis



# Result – TSA synoptic analysis

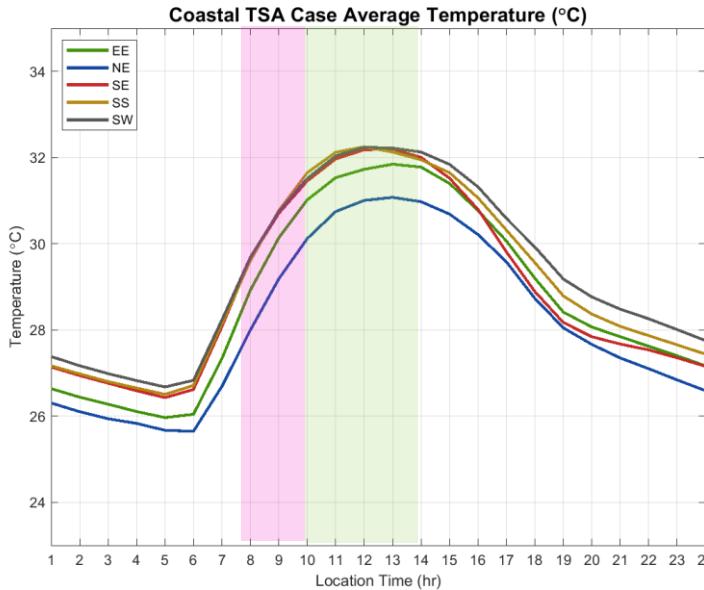
Shading (color) : 1000 hPa Geopotential Height  
 Contour (black) : 500 hPa Geopotential Height  
 Purple line :  $5880 \text{ m}^2/\text{s}^2$



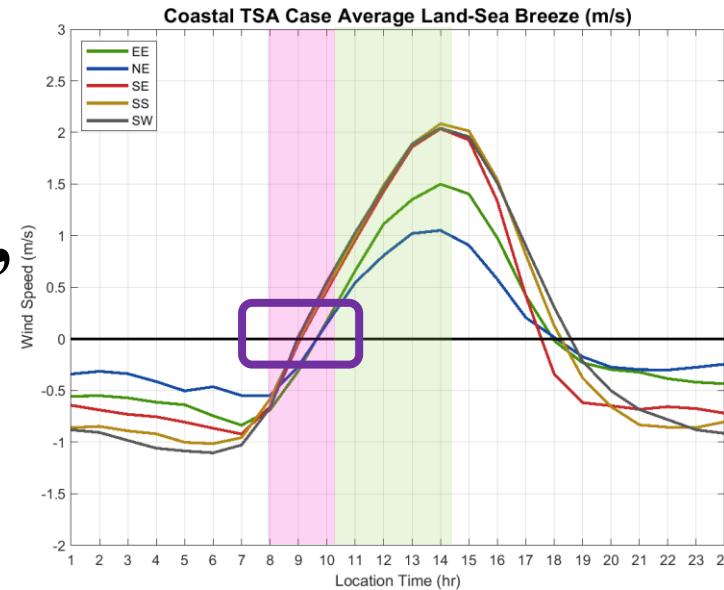
# Result – TSA surface analysis

沿海(I)區

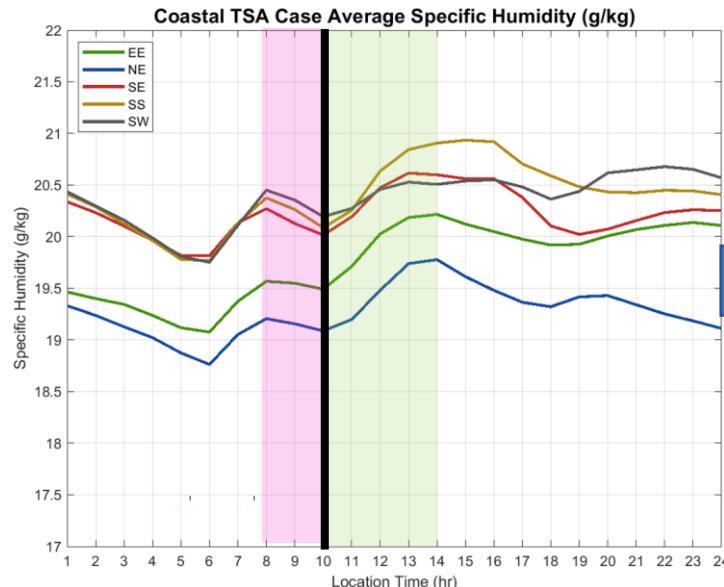
T



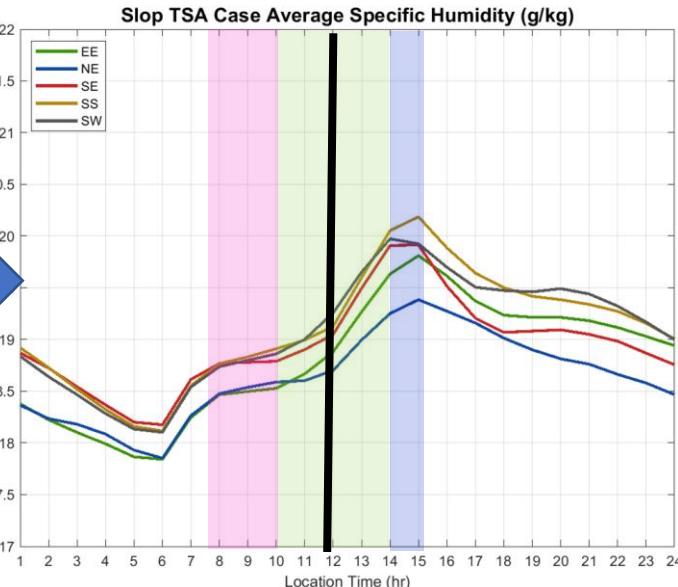
$\mathbf{U'}$



Q



I to II



Land breeze  $\rightarrow$  Sea breeze

Sea breeze increases to maximum

TSA風場距平(減日平均)  
海風：風場轉至西風

(NE  $\rightarrow$  EE  $\rightarrow$  SE  $\rightarrow$  SS  $\rightarrow$  SW)

- 隨著風場轉變，海風起始前，環境溫濕逐漸增高
- 海風起始時間點提早
- 海風的風速也受溫度影響增強：  
 $\text{SS} > \text{SW} > \text{SE} > \text{EE} > \text{SW}$
- I區輸送水氣至II區(晚約1~2hr)
- 風速極值時間點的水氣通量最大，II區水氣隨之達極值(14~15LST)

# Result – TSA precipitation analysis

NE

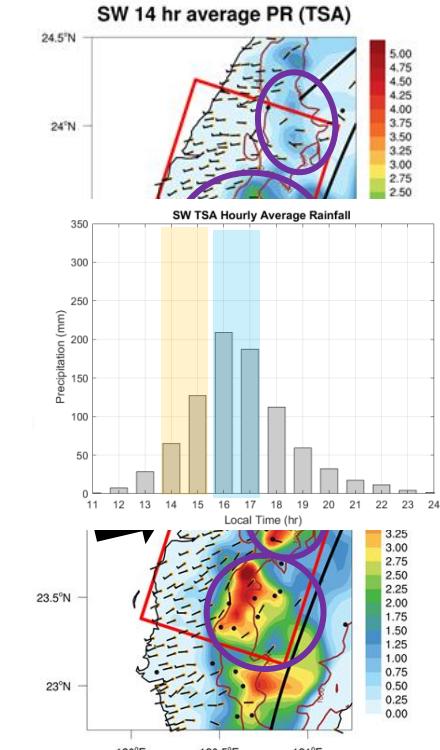
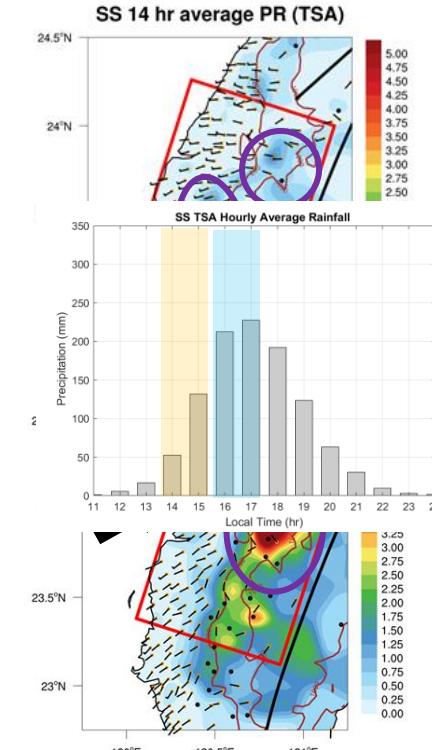
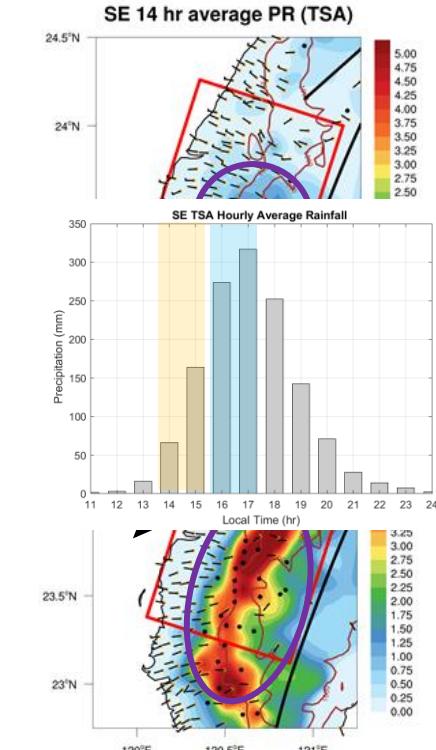
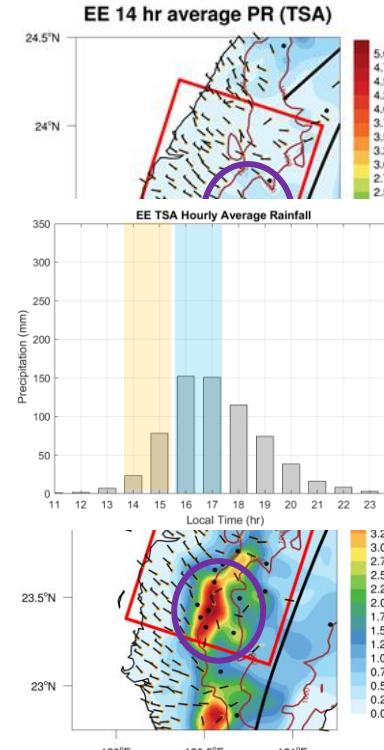
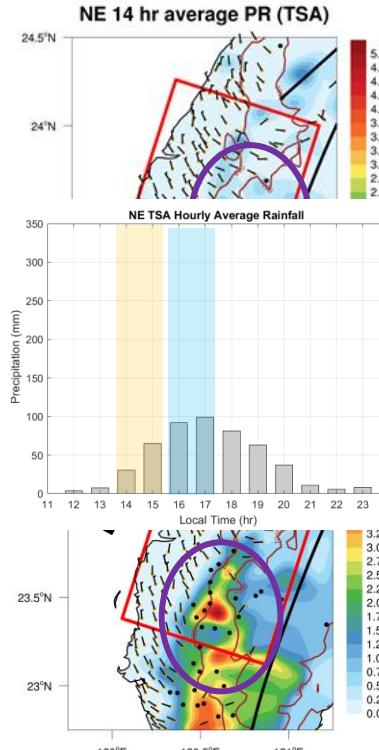
EE

SE

SS

SW

- II區水氣達極值(13~14LST)同時對流降水迅速發展，16~17LST達中部區域最大總累積降水
- 降水多在地形凸出位置生成，迎風面風場則於地形凸出及凹槽位置皆有可能生成
- 主要往斜坡區發展，而後降水熱區的位置與盛行風遇到地形的位置有關。



# Result – TSA vs noTSA synoptic analysis

1000 & 500 hPa  
Geopotential Height  
↑: TSA   ↓: noTSA

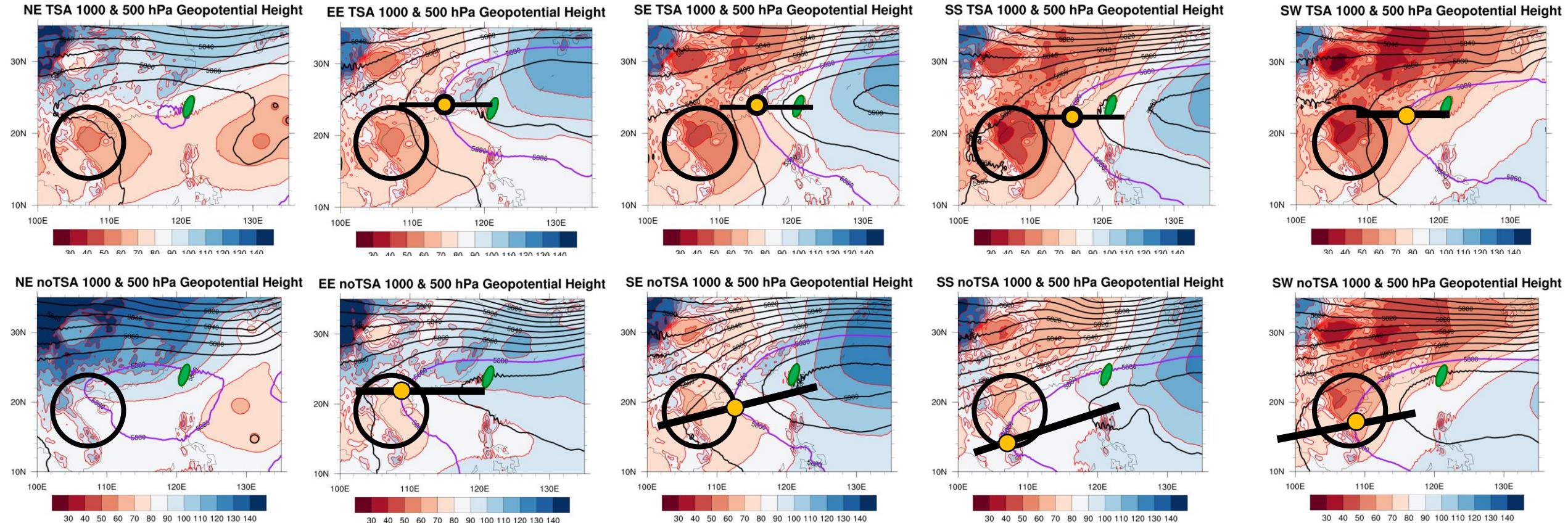
NE

EE

SE

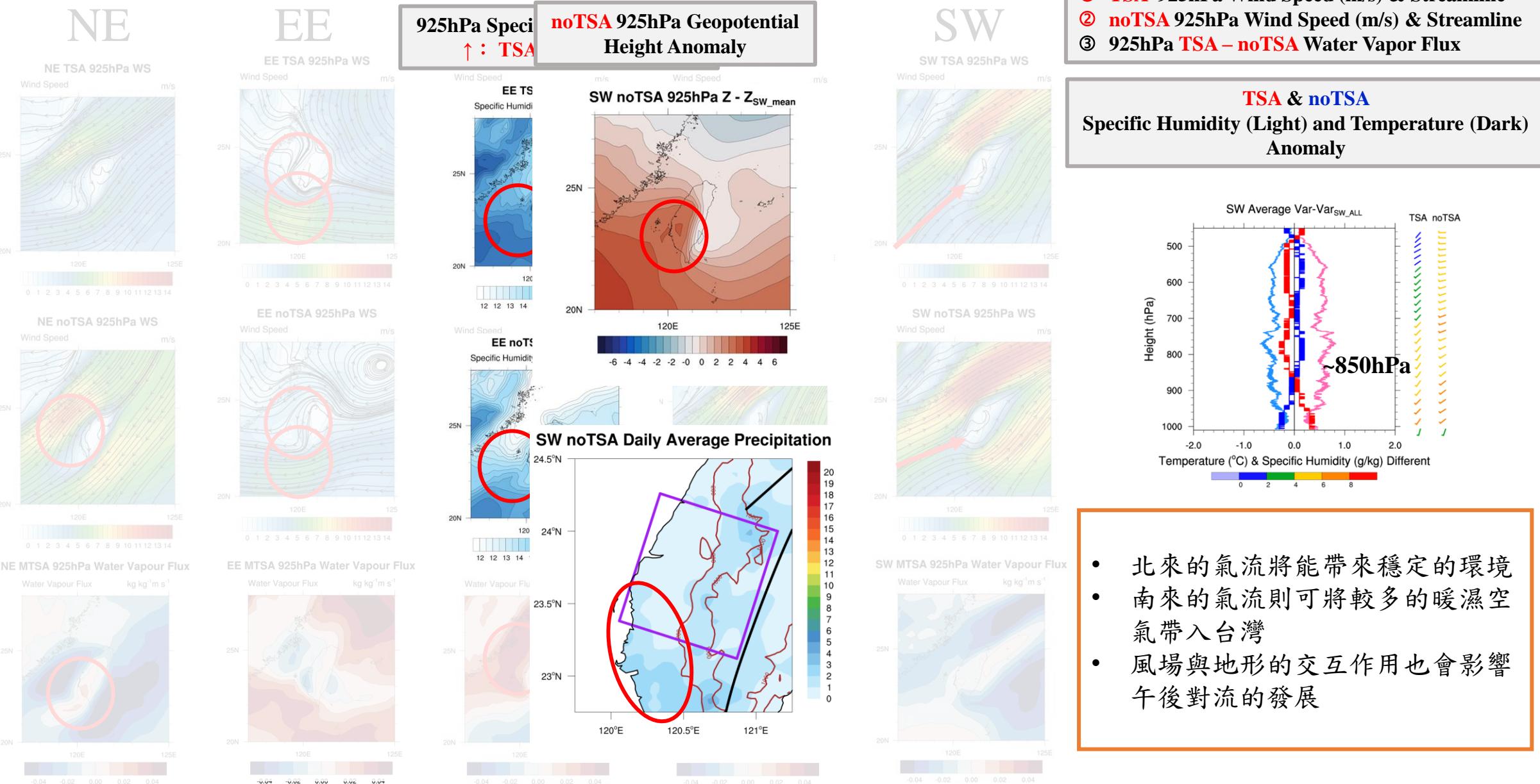
SS

SW



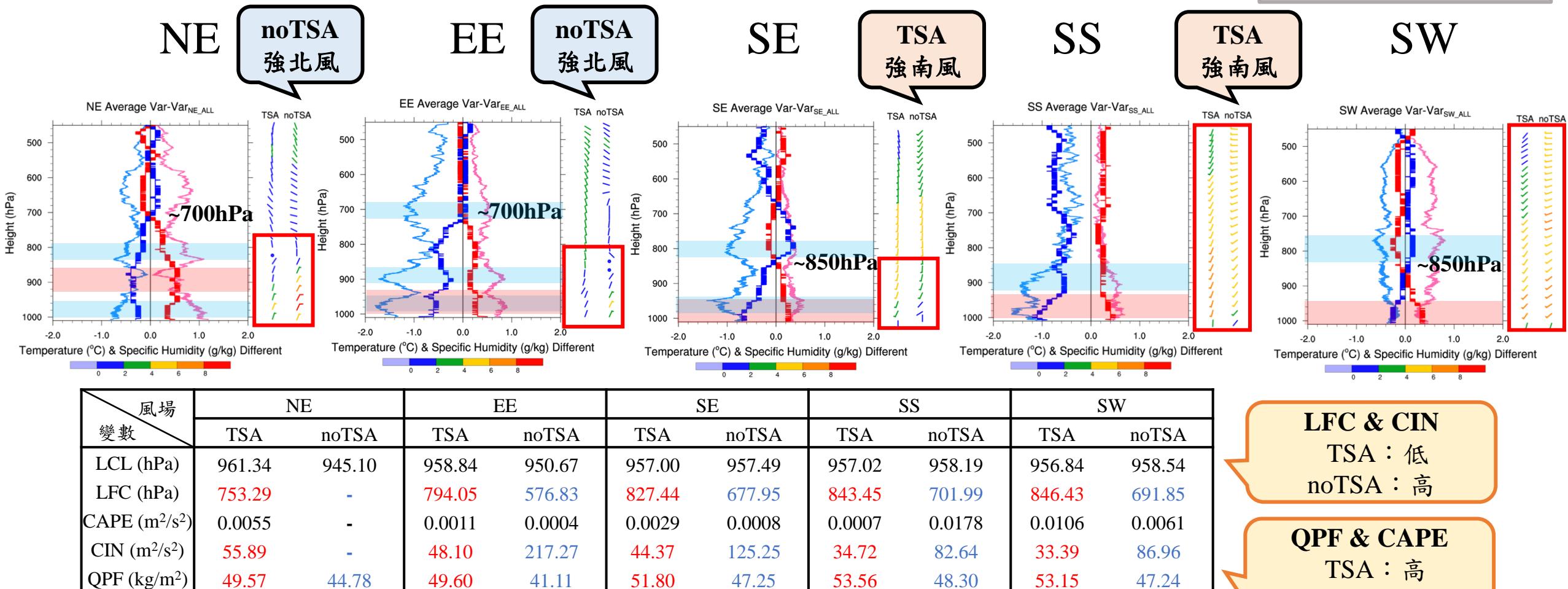
- TSA：台灣位於副高邊緣，低層南海低壓發展較強，使周圍環境趨於不穩定。
- noTSA：中層的副高的高壓脊較西伸且往南發展較廣，則會使台灣的環境趨於穩定。

# Result – TSA vs noTSA synoptic analysis



# Result – TSA vs noTSA profile analysis

**TSA & noTSA**  
Specific Humidity (Light) and  
Temperature (Dark)  
Anomaly

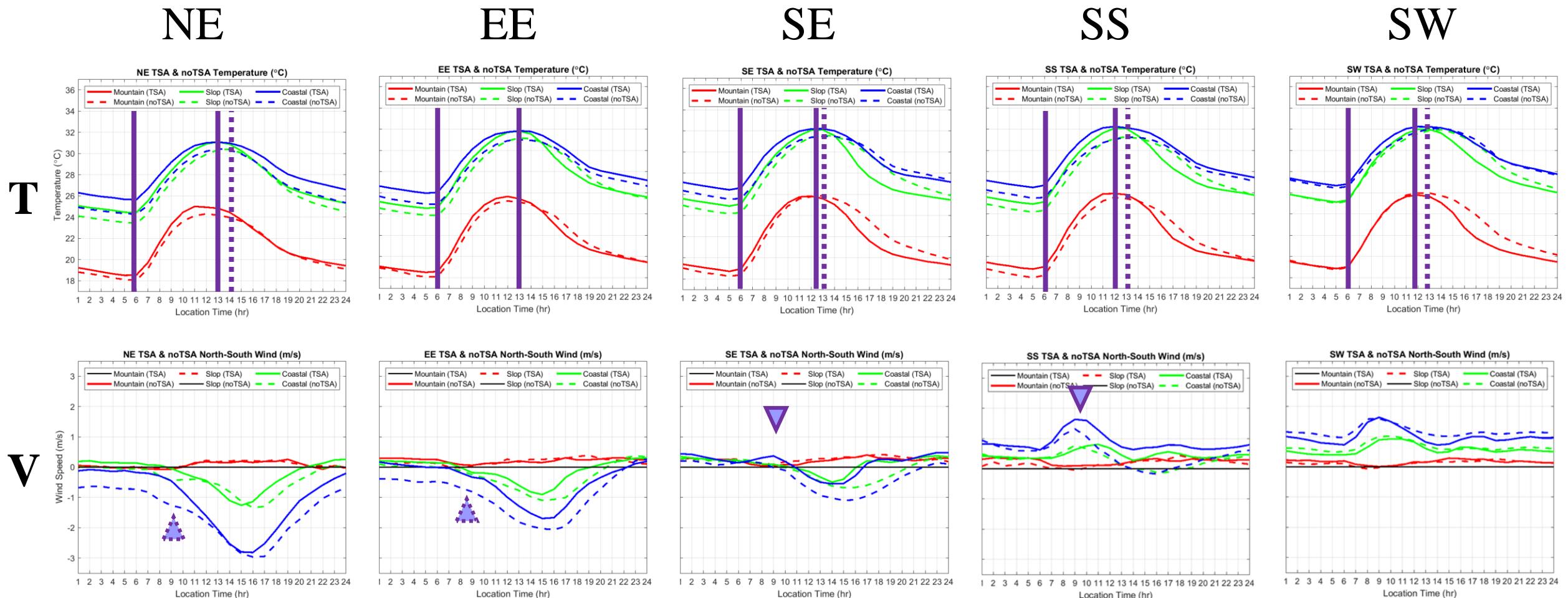


- TSA : 中低層較為溫暖，整層較潮溼
- 溫暖受盛行風場影響於中低層差異較為明顯，SW 差異最不明顯
- TSA 較暖濕環境，使不穩定度提高，有相當利於對流發展之條件

**LFC & CIN**  
TSA : 低  
noTSA : 高

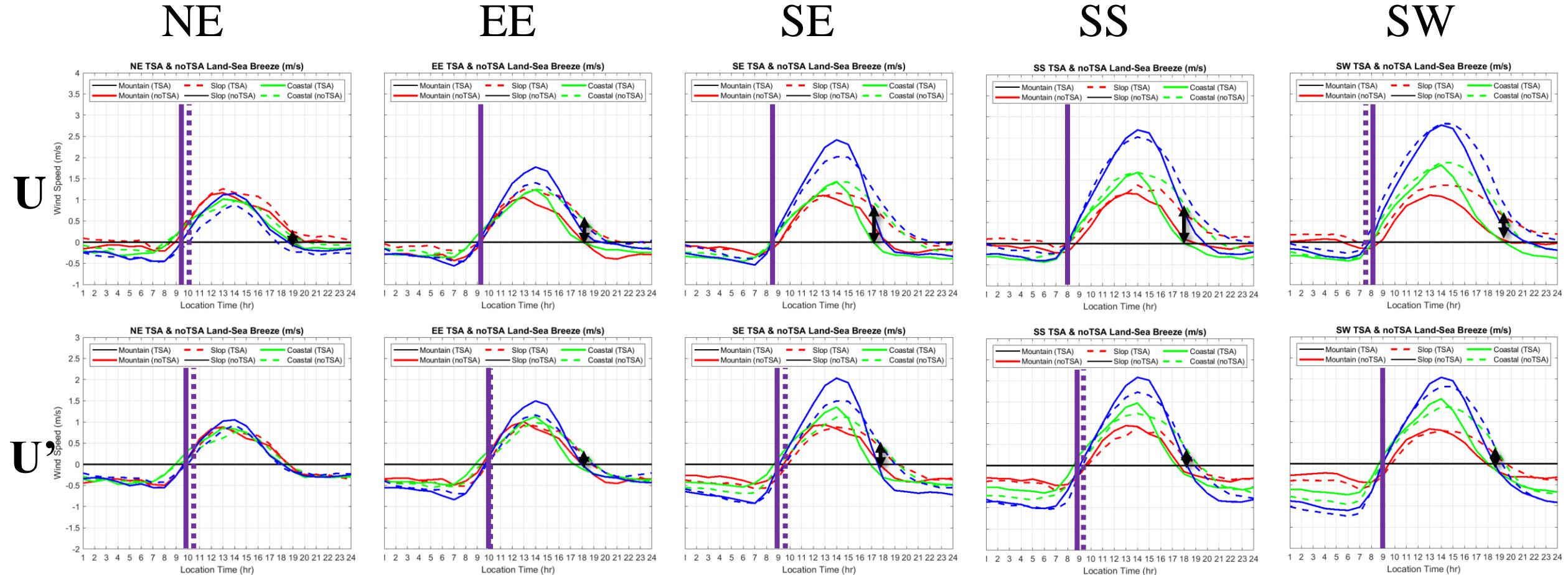
**QPF & CAPE**  
TSA : 高  
noTSA : 低

# Result – TSA vs noTSA surface analysis



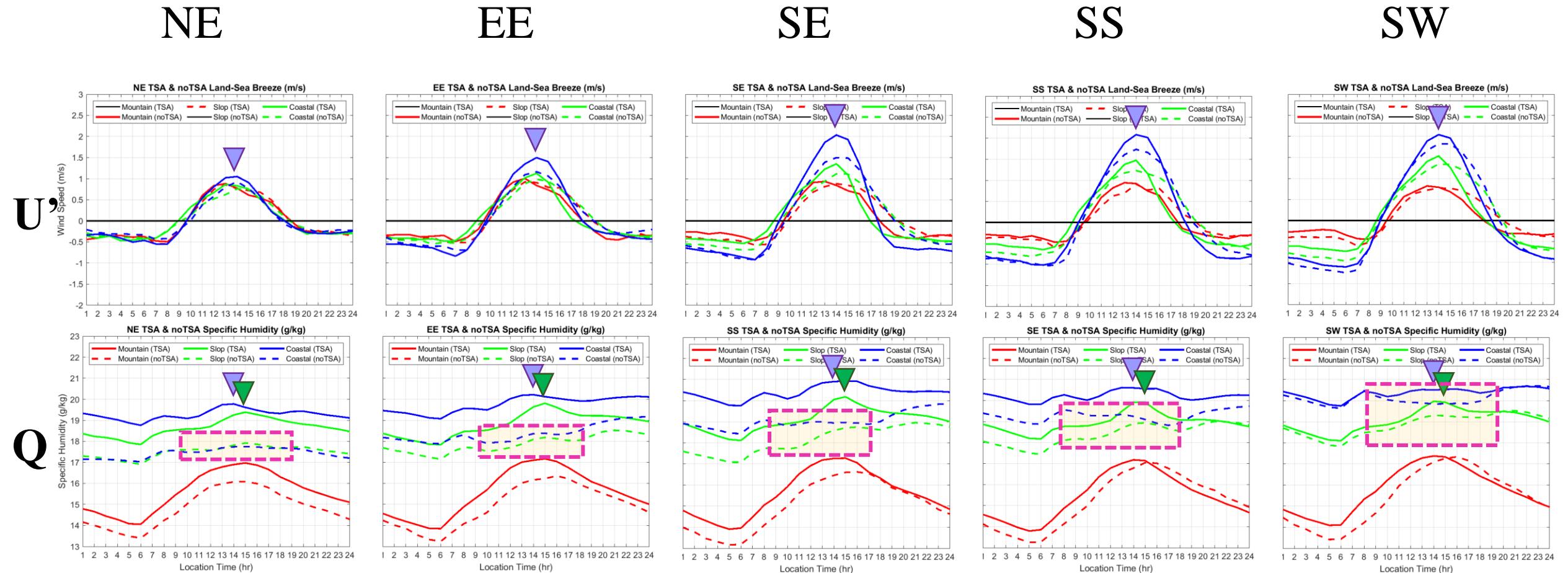
- TSA : 早上都有較溫暖的環境，SW的溫度差異最不明顯
- 溫度最大值有提早，與Chen et al. (2016)於臺北盆地的研究相似，推測受盛行風場或降水影響
- 溫度最小值無時間差異，與Chen et al. (2016)於臺北盆地的研究結果並不相同

# Result – TSA vs noTSA surface analysis



- 除NE受盛行風影響轉成西風的時間點提早外，其餘風場並無時間差異。
- 但實際的海風，除SW轉成海風的時間相同外，其餘皆有提早的趨勢，與Chen et al. (2016)於臺北盆地的研究相似。
- TSA海風較強，而降水結束後，除NE降水較弱影響不大外，其餘風場皆有提早轉陸風的情形。

# Result – TSA vs noTSA surface analysis



- TSA的水氣除SW差異最不明顯外，其餘風場都有較潮溼的環境
- TSA：海風需要夾帶足夠的水氣，並將水氣傳輸至斜坡區，供應水氣使午後對流系統生成
- noTSA：環境水氣較少，使海風發展時無法持續提供水氣至內陸區域

# Conclusion

- 綜觀風場TSA比較：(NE → EE → SE → SS → SW)

| TSA         | NE  | EE | SE   | SS    | SW    |
|-------------|---|----|------|-------|-------|
| 高度場         | 高壓位置有逐漸往東南方向退去的趨勢，南海低壓逐漸增強                |    |      |       |       |
| 溫溼度場 & 穩穩定度 | 中低層環境趨於暖濕，不穩定度逐漸增加，只需較少的外力作用即可造成對流不穩定發生   |    |      |       |       |
| 海陸風場        | 地表溫度逐漸增高，溫度差異也使得陸風轉海風的時間點提早，海風的發展也隨之增強    |    |      |       |       |
| 海風起始時間      | 受溫度的影響，海風起始時間有提早的趨勢                       |    |      |       |       |
| 降水時間        | 斜坡區水氣於13~14LST達極值，同時對流迅速發展，至16~17LST達最大降水 |    |      |       |       |
| 降水初始位置      | 降水多在地形凸出位置生成，迎風面風場則於地形凸出及凹槽位置皆有可能生成       |    |      |       |       |
|             | 凸出  | 凸出 | 凸出   | 凸出+凹槽 | 凸出+凹槽 |
| 降水熱區        | 主要往斜坡區發展，而後降水熱區的位置與盛行風遇到地形的位置有關           |    |      |       |       |
|             | 凸出偏南                                      | 凸出 | 南北延伸 | 北方凹槽  | 原地增強  |

# Conclusion

- 各綜觀風場TSA & noTSA環境場比較：

| TSA vs noTSA | NE   | EE   | SE              | SS     | SW     |
|--------------|--|--|-----------------|--------|--------|
| 高度場          |  | TSA：台灣位於副高邊緣，低層南海低壓發展較強<br>noTSA：中層的副高的高壓脊較西伸且往南發展較廣           |                 |        |        |
| 綜觀風場         |  | 北來的氣流將能帶來穩定的環境<br>南來的氣流則可將較多的暖濕空氣帶入台灣<br>風場與地形的交互作用也會影響午後對流的生成 |                 |        |        |
| 溫溼度場         |  | TSA：中低層較為溫暖，整層較潮溼，早上都有較暖濕的環境                                   |                 |        |        |
| 溫度差異最大位置     | 900hPa   | 950hPa   | 近地表             | 近地表    | 近地表    |
|              | (溫度差異大小)   | SS > NE > EE > SE > SW   |                 |        |        |
| 水氣差異最大位置     | 800hPa & 近   | 700hPa & 900hPa  | 800hPa & 925hPa | 900hPa | 800hPa |
| 穩定度          |  | TSA：不穩定度高，有相當利於對流發展之條件   |                 |        |        |
|              | (條件不穩定度)   | SW > SS > SE > EE > NE   |                 |        |        |
|              | (對流抑制位能)   | NE > EE > SE > SS > SW   |                 |        |        |
|              | (可降水量)   | SW > SS > SE > EE > NE   |                 |        |        |
| 海陸風變化        | TSA：受溫度的影響，實際的海風，除SW轉成海風的時間相同外，其餘皆有提早的趨勢           |  |                 |        |        |
| 海風水氣傳輸       | TSA：海風需要夾帶足夠的水氣，並將水氣傳輸至斜坡區(約晚1~2hr)，供應水氣利於午後對流系統發展 |  |                 |        |        |

# Future work

- 補上與綜觀合成風場相似的強午後對流降水與非午後對流降水個案討論，並詳細分析各風場的比較及TSA與noTSA的結果。



降水區 & 降水強度

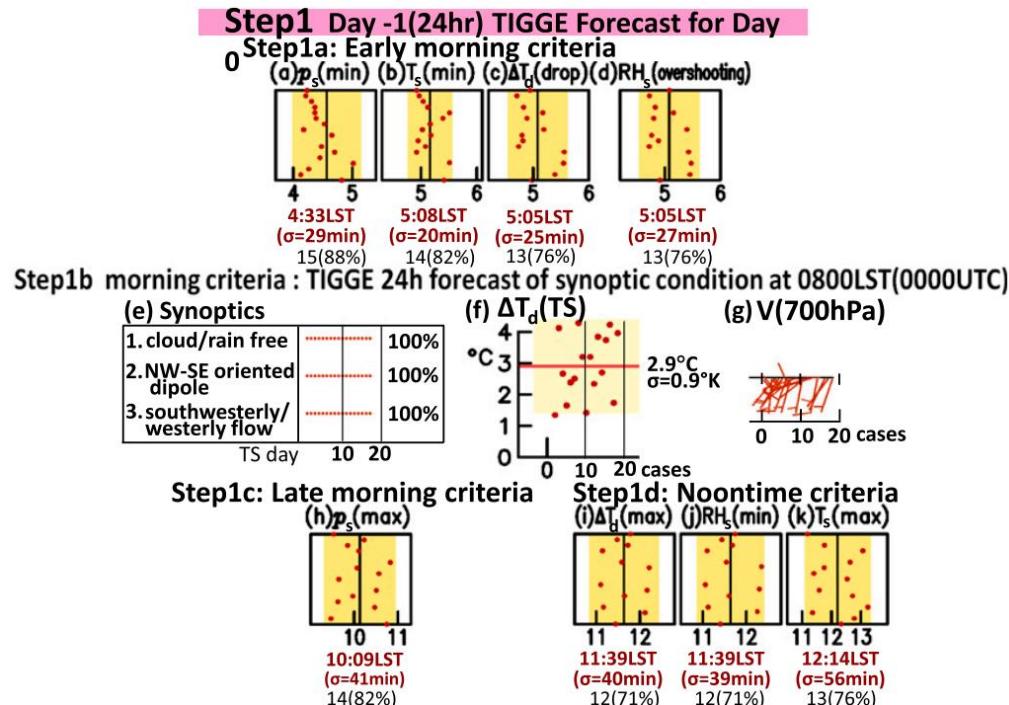
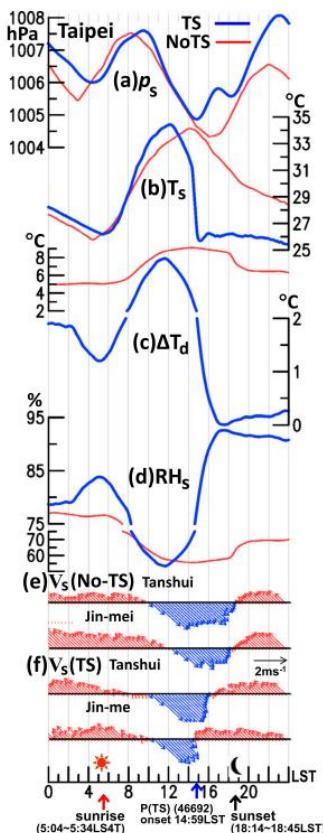


探討過山沉降作用影響

# Future outlook

- 增加分析的時空間解析度，以及加強各綜觀風場下的對流降水機制、強度以及移動的統計分析討論。
- 依資料統計量化並詳細分出各環境因子所影響午後對流發生的程度，嘗試利用類似Lin et al. (2012)與Chen et al. (2016)的方法，得出在各個時間空間上午後對流的發生機率，建立一套針對中部區域的午後對流預報系統。

$$p_{k,s}(x) = \frac{n(X_k = x \cap \text{day type} = s)}{n(X_k = x)}$$



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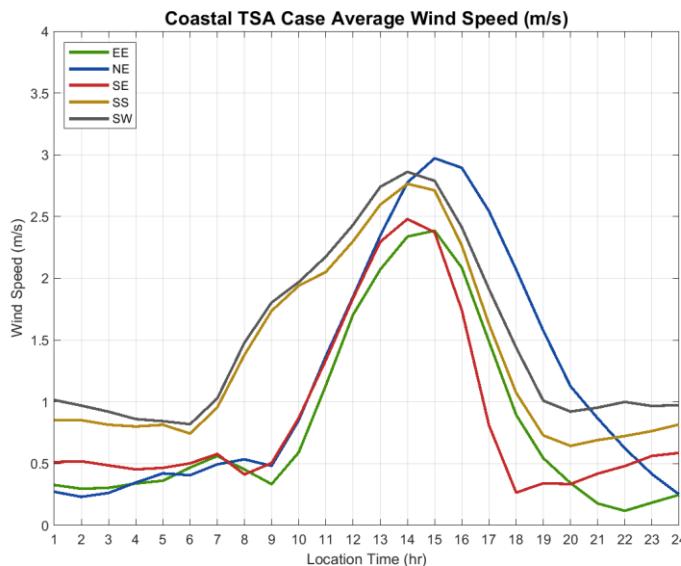
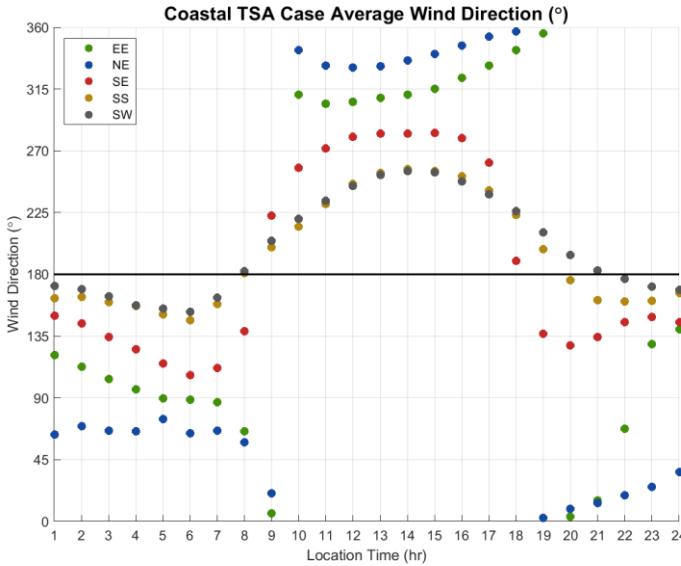


# References

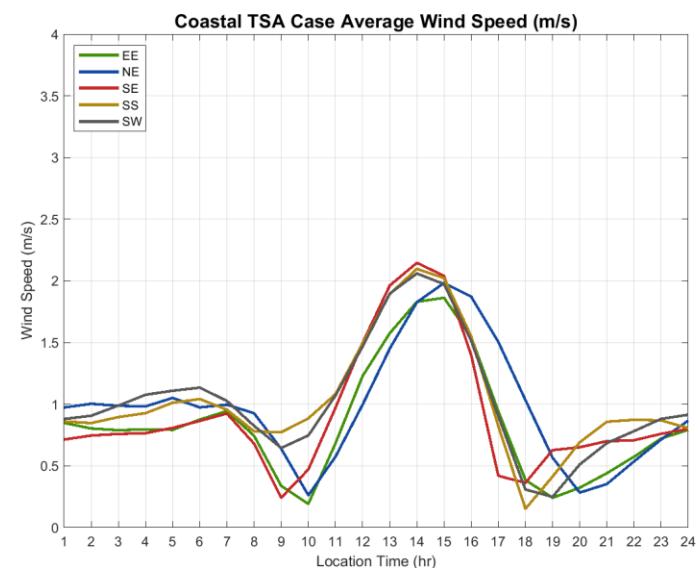
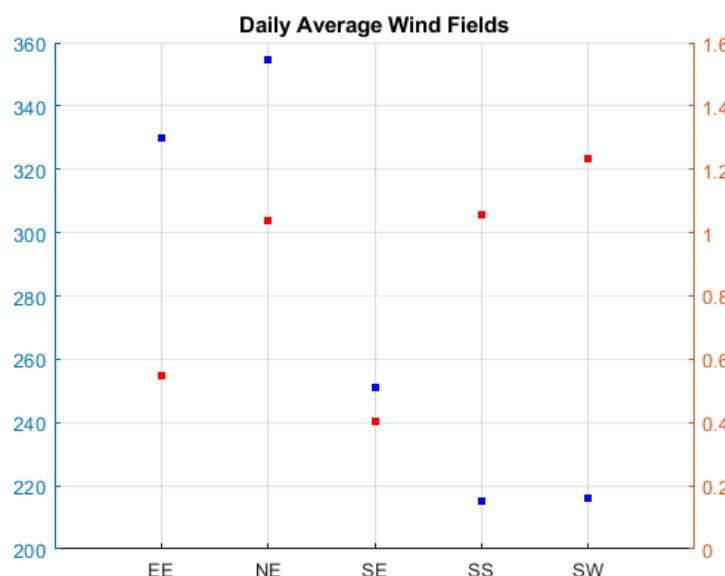
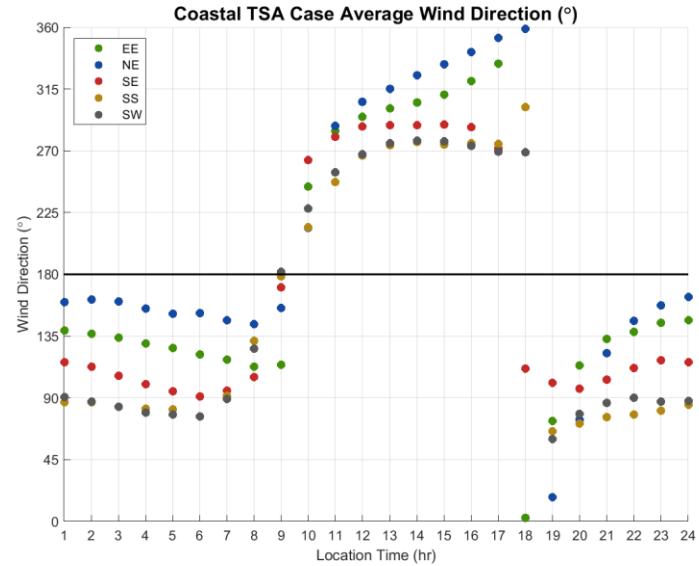
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**Thank you for your attention**

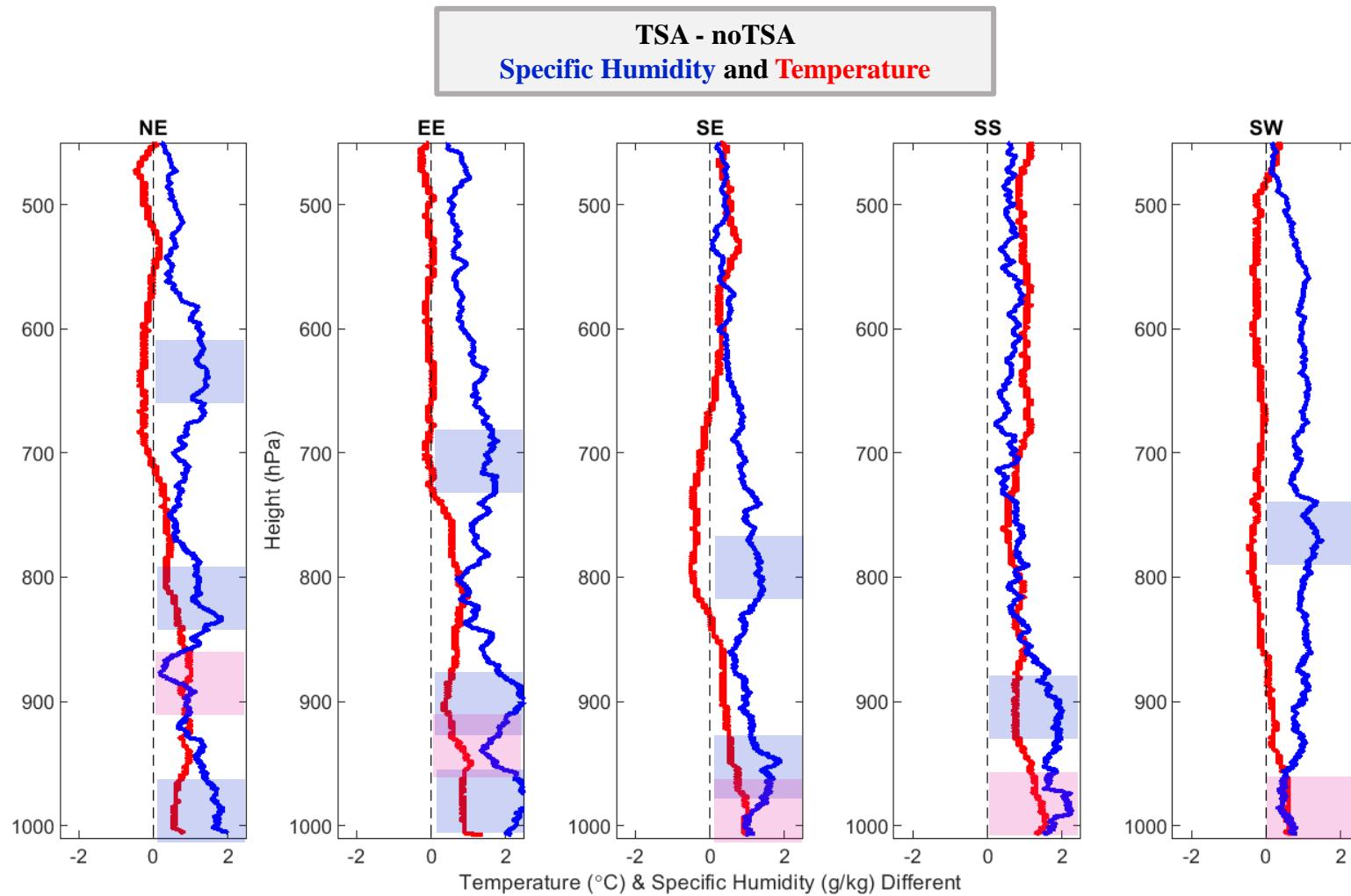
# 盛行風



# 海陸風



# Result – TSA vs noTSA profile analysis

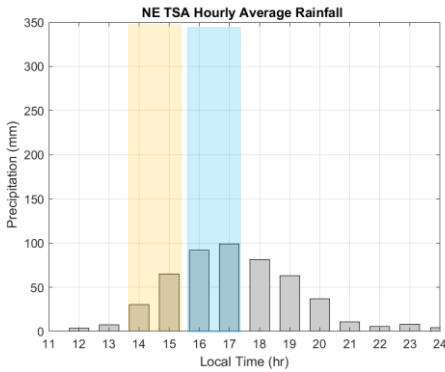


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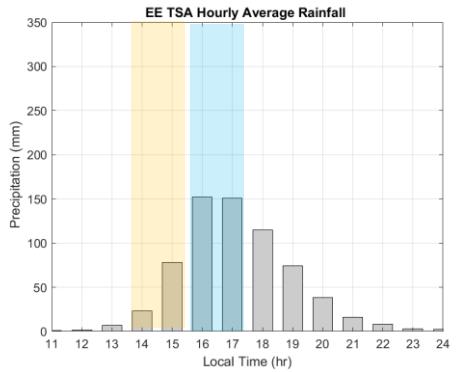
濕程度 : SW < NE < SE < EE < SS

# Result – TSA precipitation analysis v

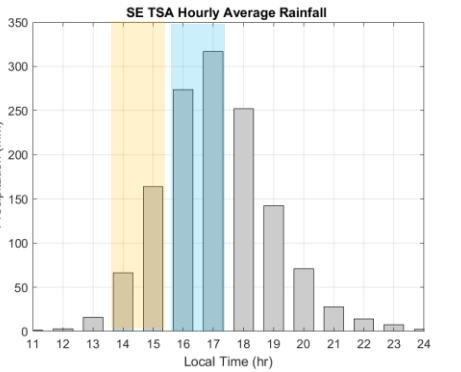
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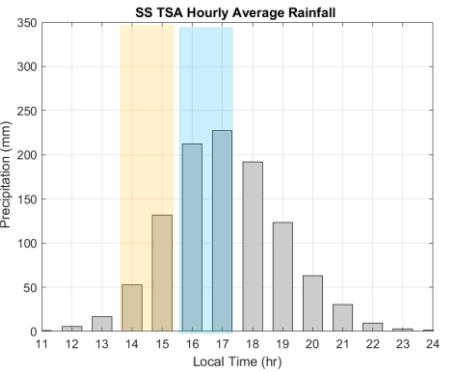
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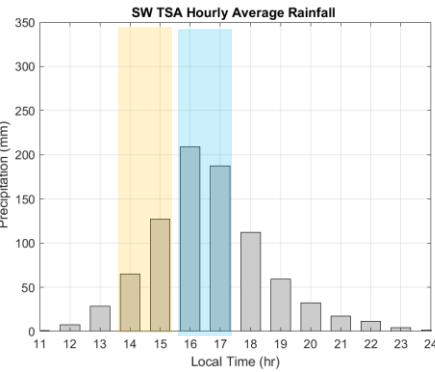
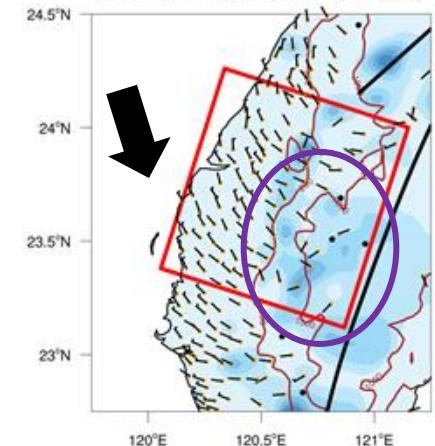
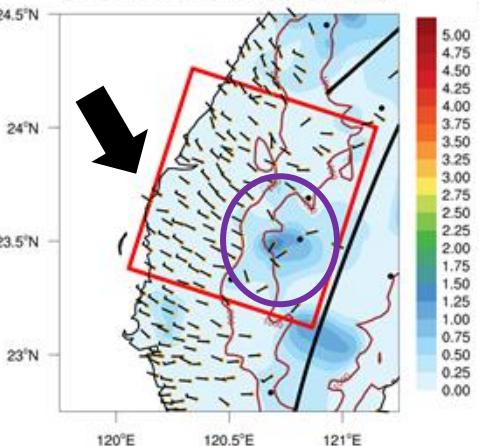
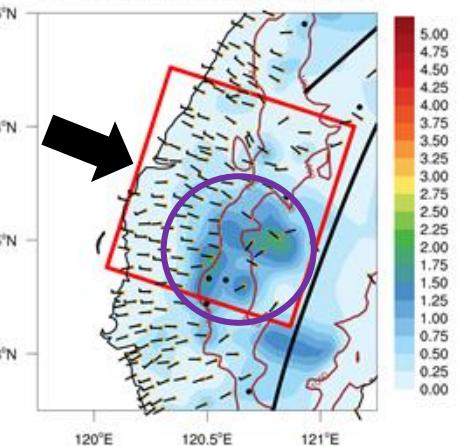
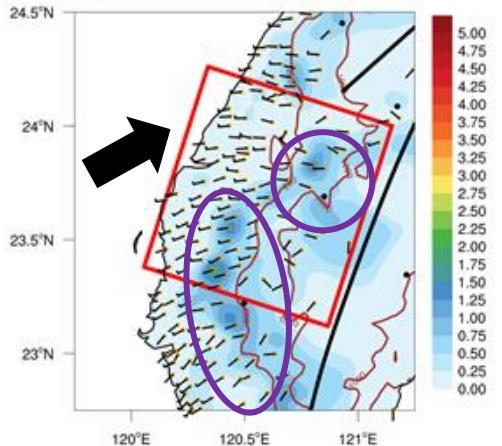
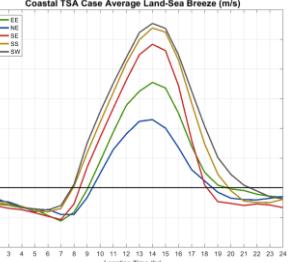
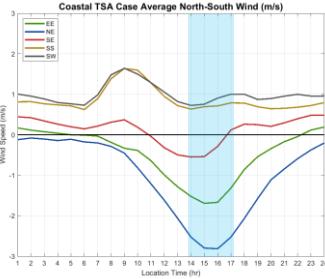
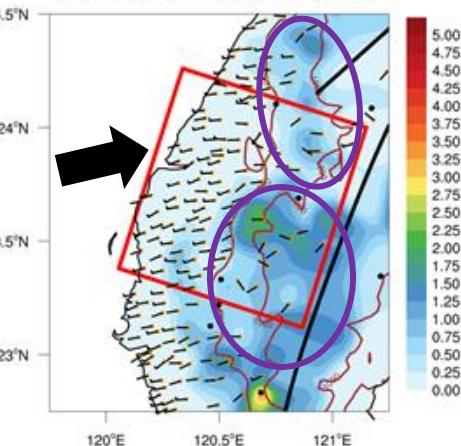
SE



SS



SW

**NE 14 hr average PR (TSA)****EE 14 hr average PR (TSA)****SE 14 hr average PR (TSA)****SS 14 hr average PR (TSA)****SW 14 hr average PR (TSA)**

# Result – TSA vs noTSA stability analysis

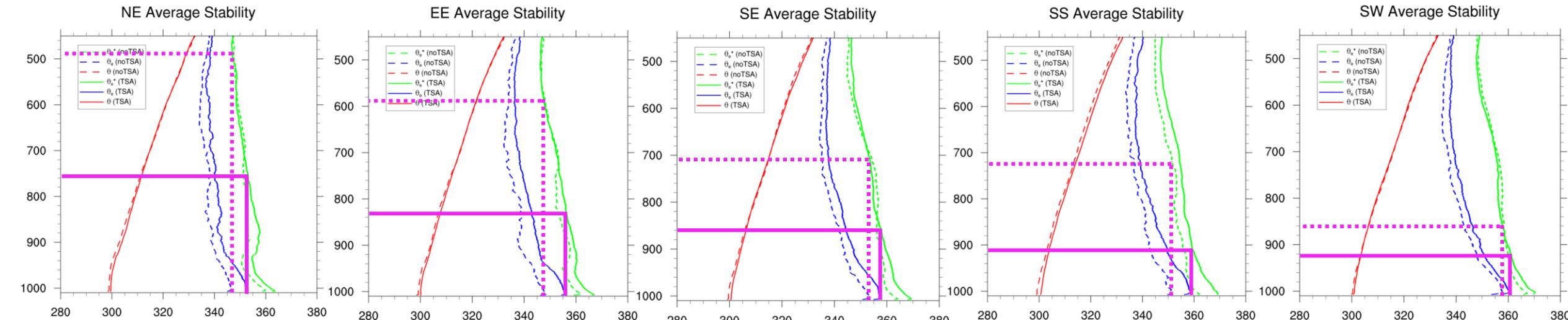
NE

EE

SE

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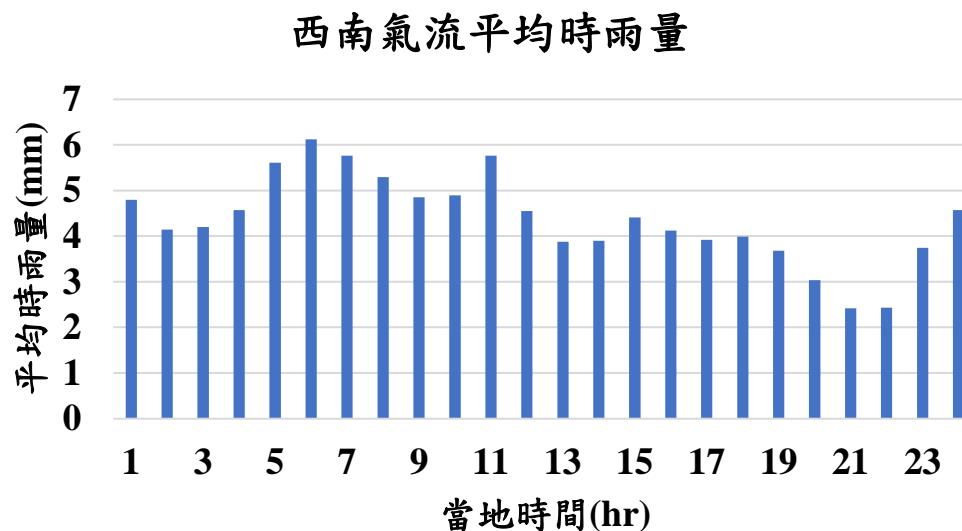
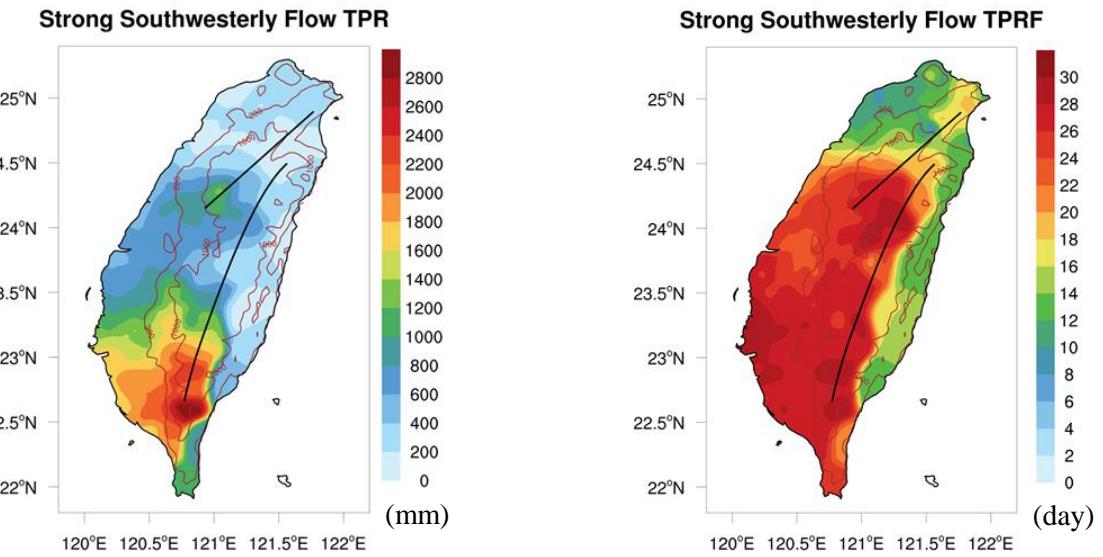
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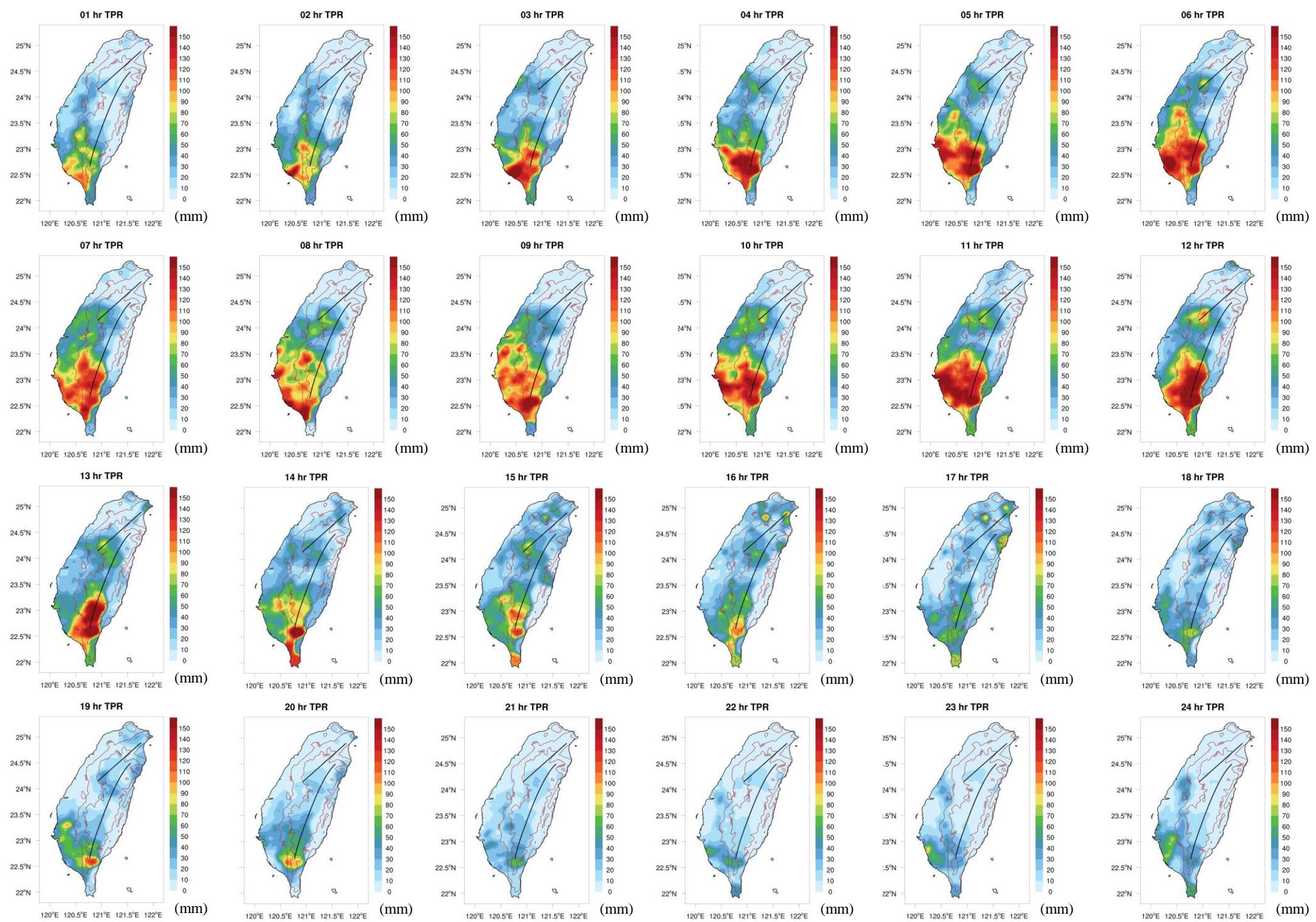


| 風場<br>變數           | NE     |        | EE     |        | SE     |        | SS     |        | SW     |        |
|--------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                    | TSA    | noTSA  |
| LCL (hPa)          | 961.34 | 945.10 | 958.84 | 950.67 | 957.00 | 957.49 | 957.02 | 958.19 | 956.84 | 958.54 |
| LFC (hPa)          | 753.29 | -      | 794.05 | 576.83 | 827.44 | 677.95 | 843.45 | 701.99 | 846.43 | 691.85 |
| CAPE ( $m^2/s^2$ ) | 0.0055 | -      | 0.0011 | 0.0004 | 0.0029 | 0.0008 | 0.0007 | 0.0178 | 0.0106 | 0.0061 |
| CIN ( $m^2/s^2$ )  | 55.89  | -      | 48.10  | 217.27 | 44.37  | 125.25 | 34.72  | 82.64  | 33.39  | 86.96  |
| QPF ( $kg/m^2$ )   | 49.57  | 44.78  | 49.60  | 41.11  | 51.80  | 47.25  | 53.56  | 48.30  | 53.15  | 47.24  |

# Methodology – Strong Southwesterly flow

| Synoptic systems     | May           | Jun | Jul | Aug | Sep | ALL | Priority |
|----------------------|---------------|-----|-----|-----|-----|-----|----------|
| Front                | 72            | 49  | 2   | -   | 9   | 132 | ②        |
| Low pressure systems | 2             | 13  | 49  | 73  | 61  | 198 | ①        |
| Southwesterly flow   | 3             | 5   | 12  | 11  | -   | 31  | ③        |
| Total                | 77            | 67  | 63  | 84  | 70  | 361 |          |
| Weak Synoptic        | 73            | 83  | 89  | 71  | 79  | 395 |          |
| Other                | 9 day no data |     |     | 765 |     |     |          |

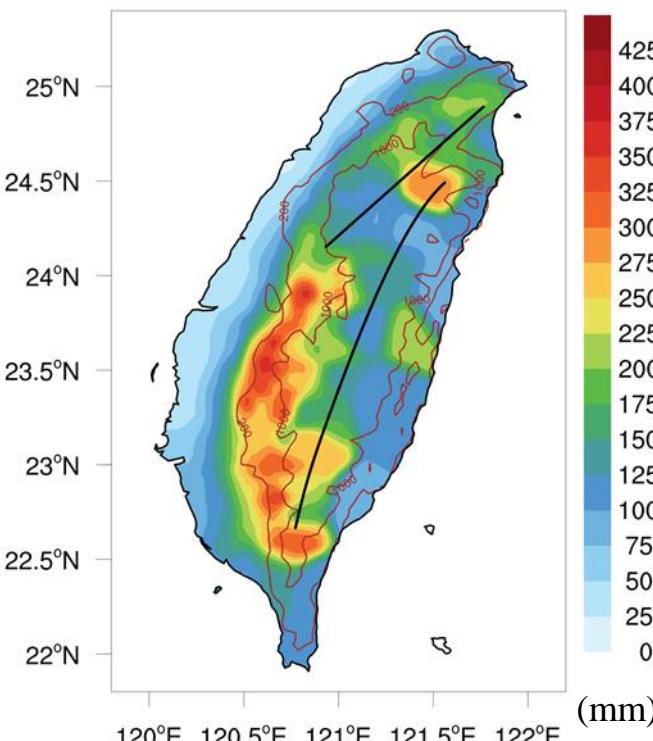




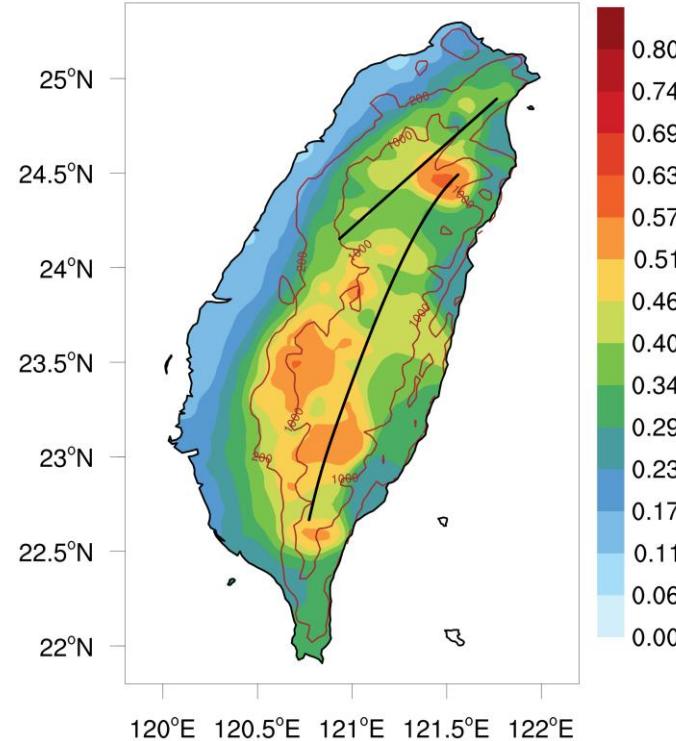
# Methodology – Weak synoptic

Use the **inverse distance weighting function** with an influence radius of 1 km to convert the data from the survey site to a mesh data with a resolution of 3 km

**weak synoptic total precipitation**

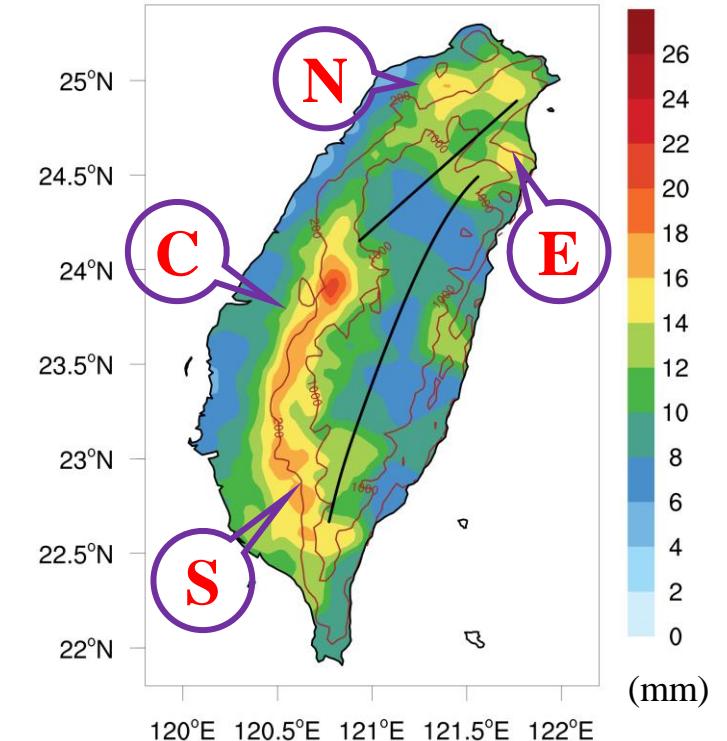


**weak synoptic precipitation frequency**



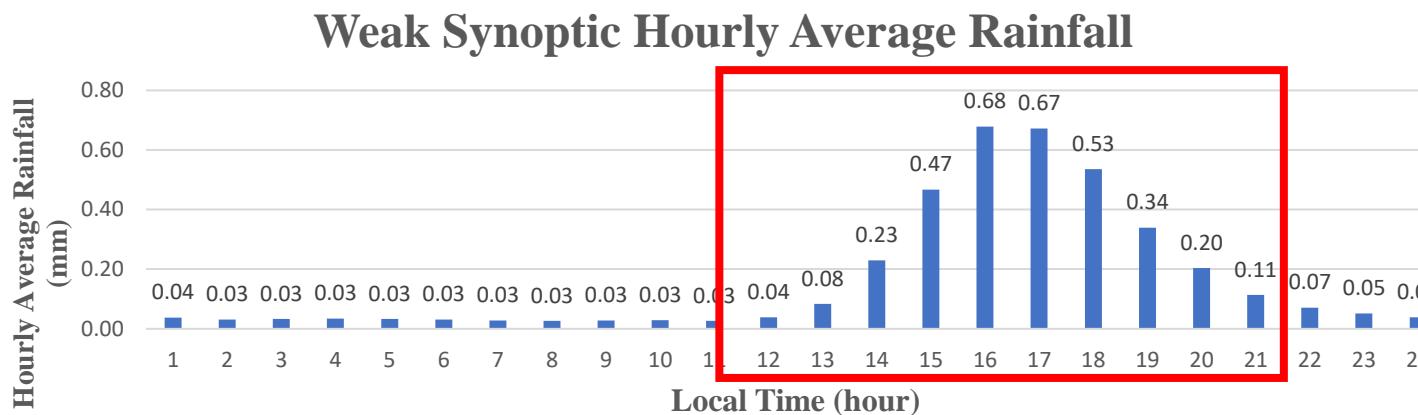
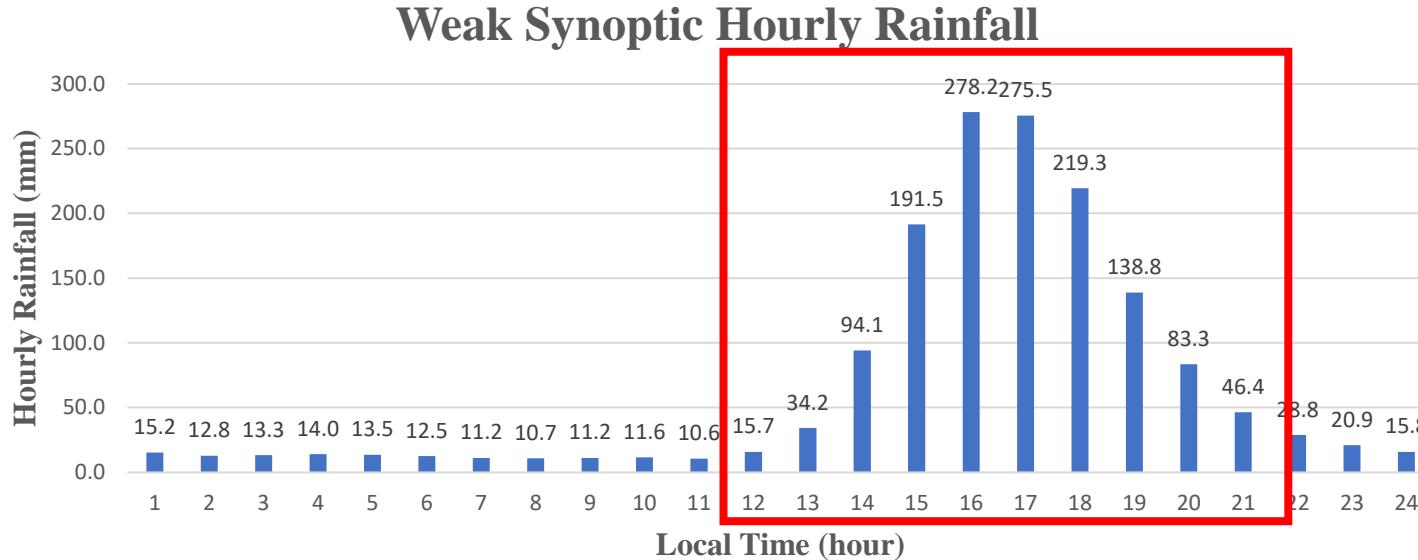
Precipitation day / Weak synoptic day  
(for each station)

**weak synoptic average daily precipitation**



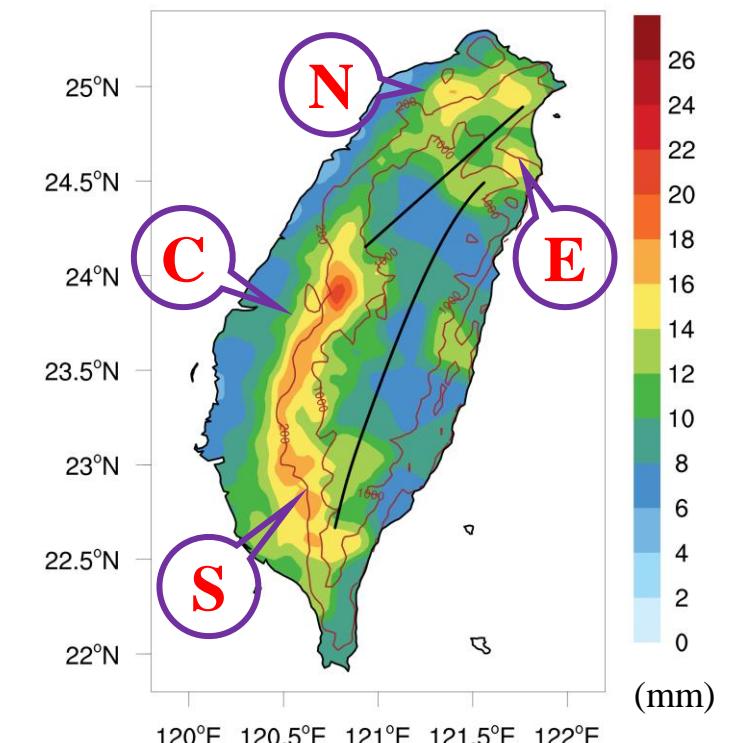
total precipitation/Precipitation day  
(for each station)

# Methodology – Weak synoptic



Use the **inverse distance weighting function** with an influence radius of 1 km to convert the data from the survey site to a mesh data with a resolution of 3 km

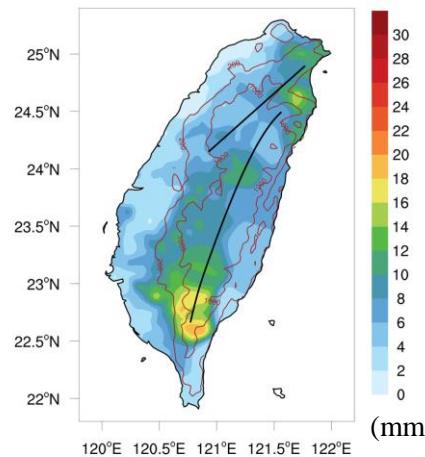
**Lin et al. (2011), 林(1996), 張(1997)**  
**weak synoptic average daily precipitation**



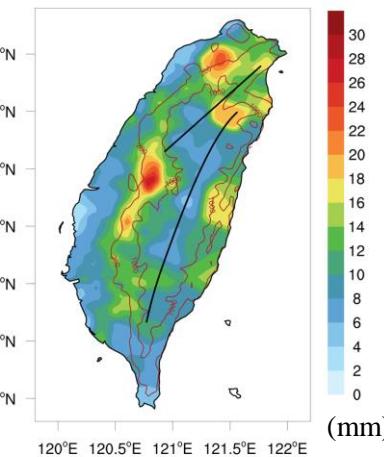
**Total precipitation/Precipitation day (for each station)**

# Methodology – Weak Synoptic

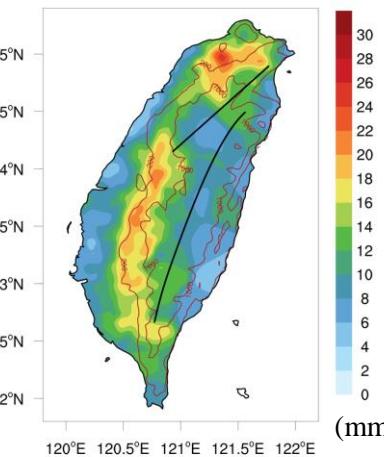
05 Weak Synoptic Average PR



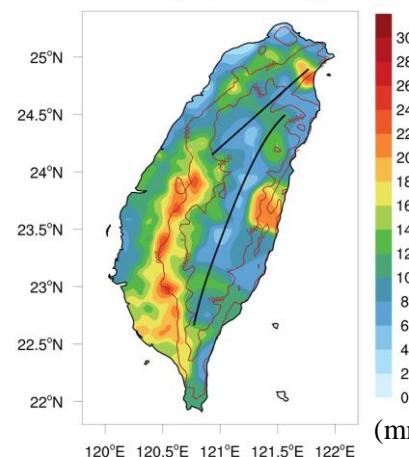
06 Weak Synoptic Average PR



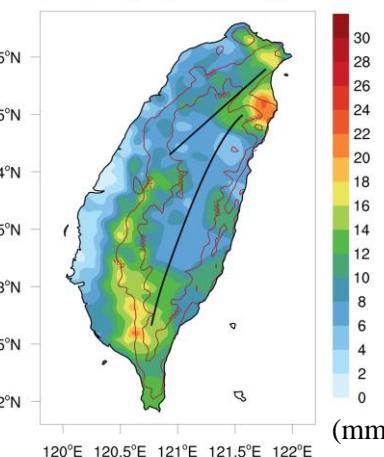
07 Weak Synoptic Average PR



08 Weak Synoptic Average PR

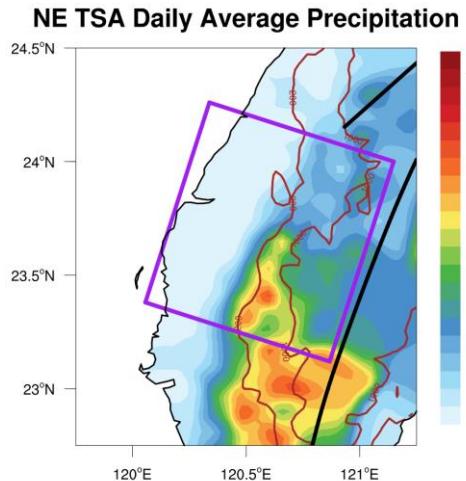


09 Weak Synoptic Average PR

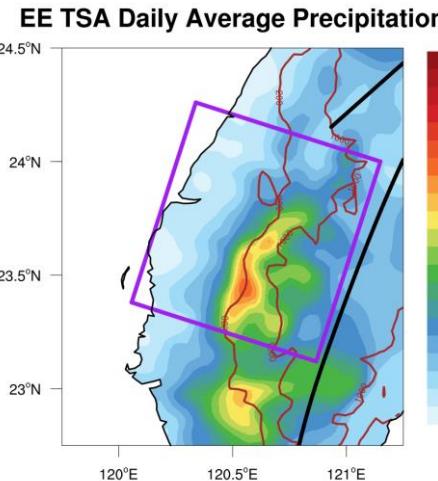


# 總降水與最大降水

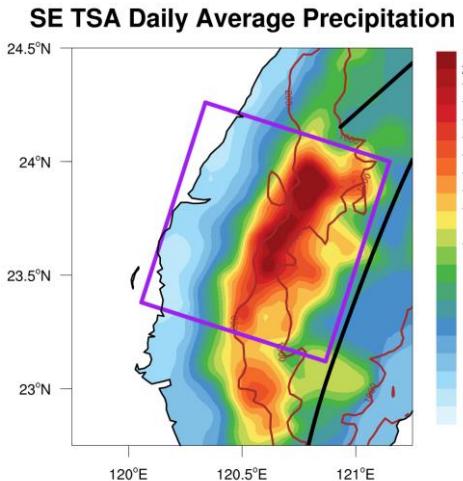
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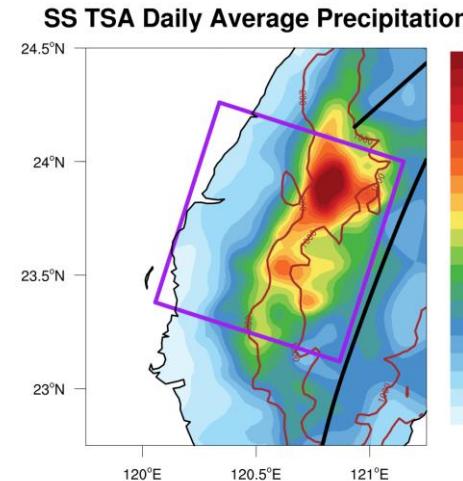
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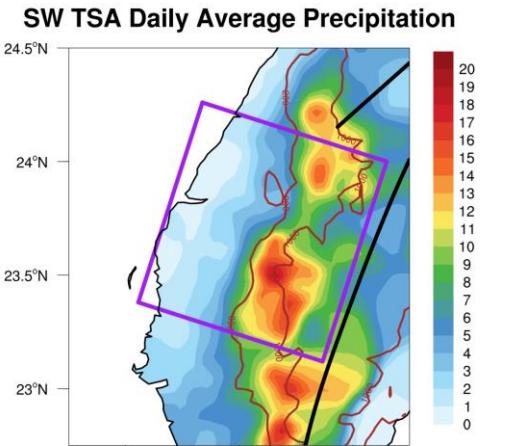
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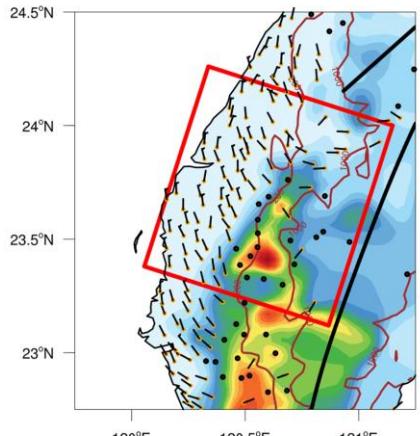
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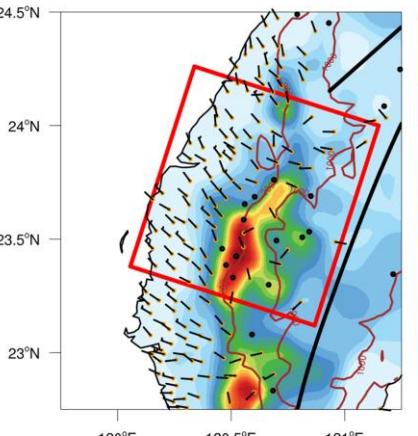
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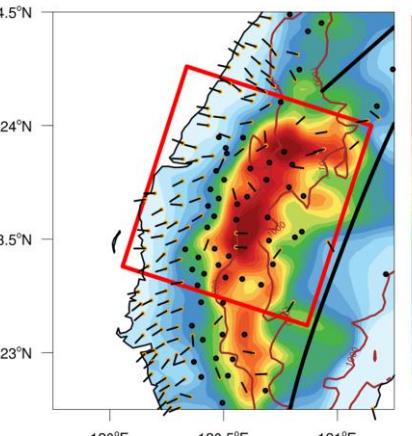
NE 17 hr average PR (TSA)



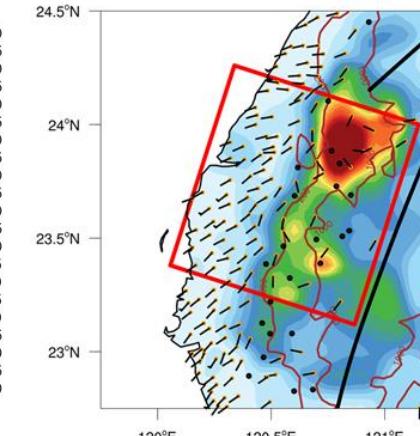
EE 16 hr average PR (TSA)



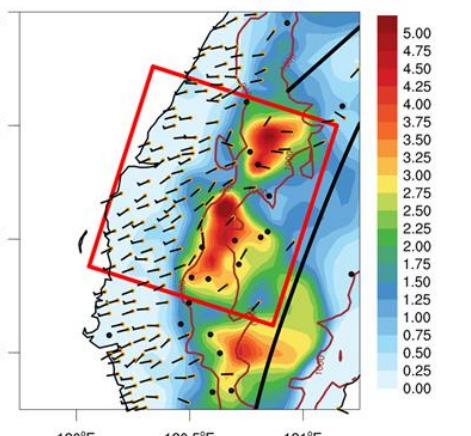
SE 17 hr average PR (TSA)



SS 17 hr average PR (TSA)



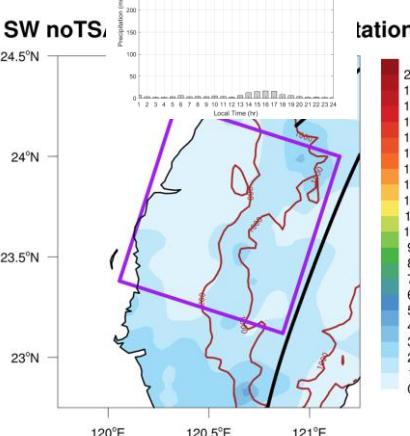
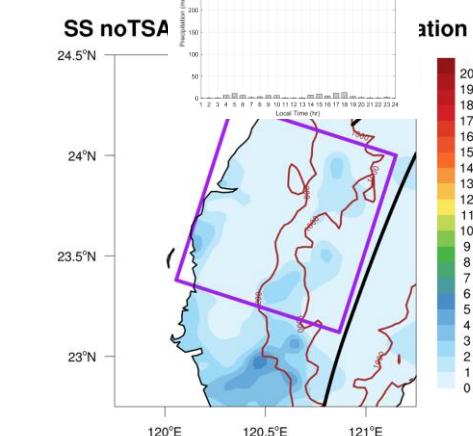
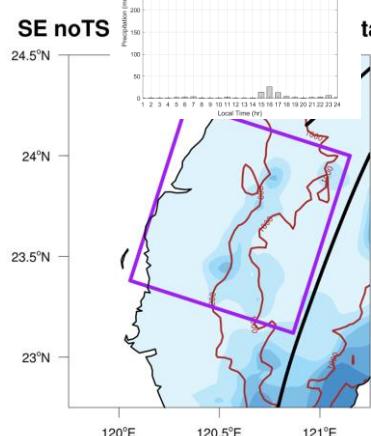
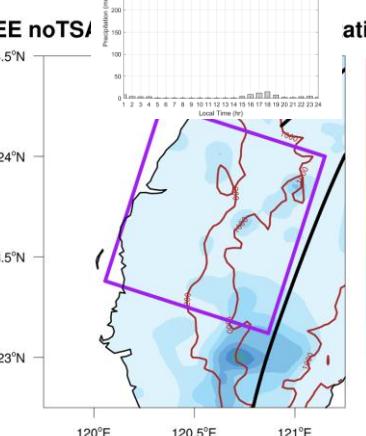
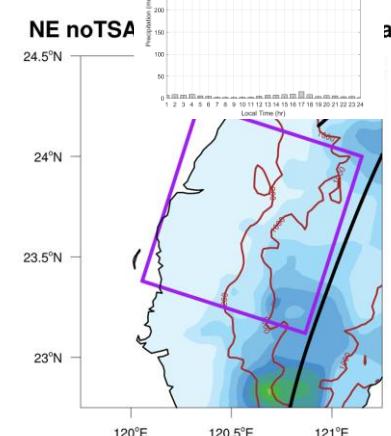
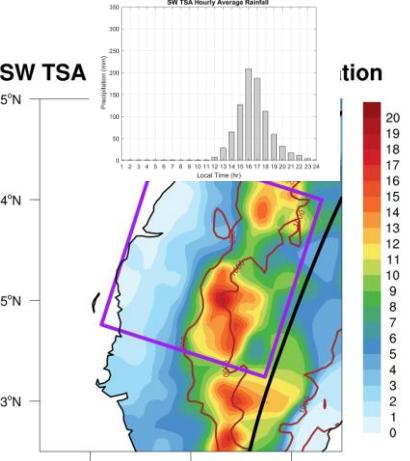
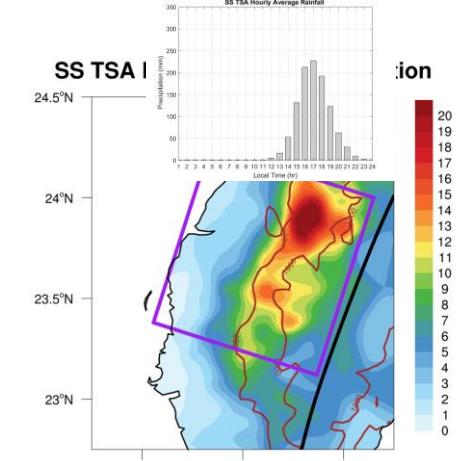
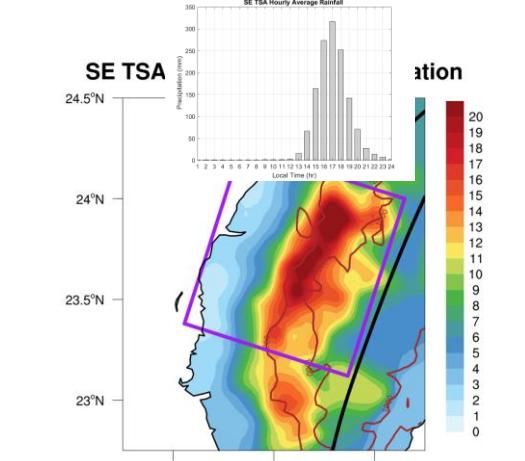
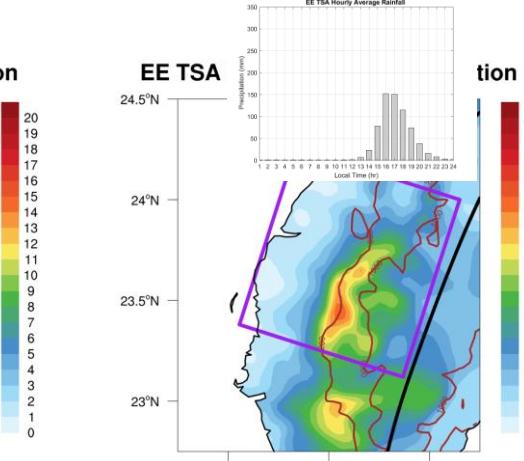
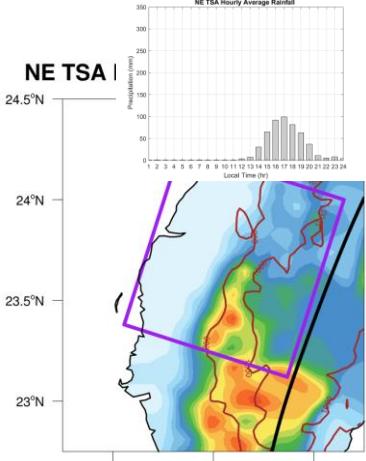
SW 16 hr average PR (TSA)



# Result – TSA precipitation analysis



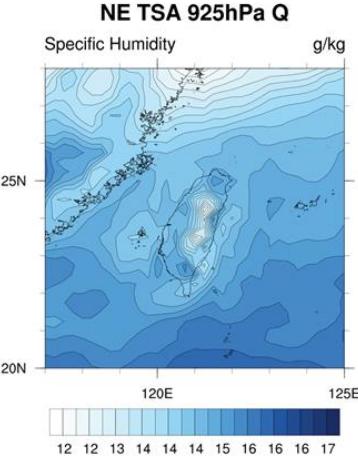
**NE**



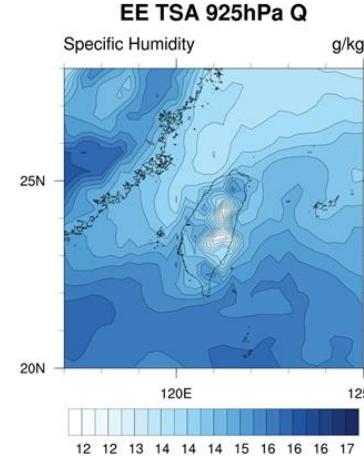
# Result – TSA synoptic analysis

↑ : 925hPa Specific Humidity (g/kg)  
 ↓ : 925hPa Wind Speed (m/s) & Streamline

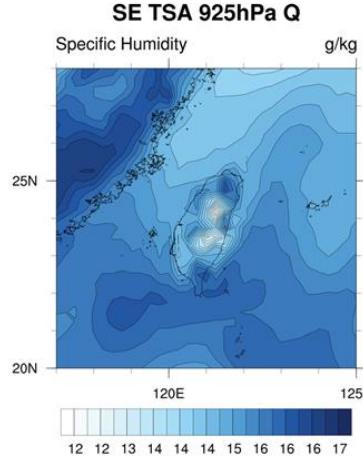
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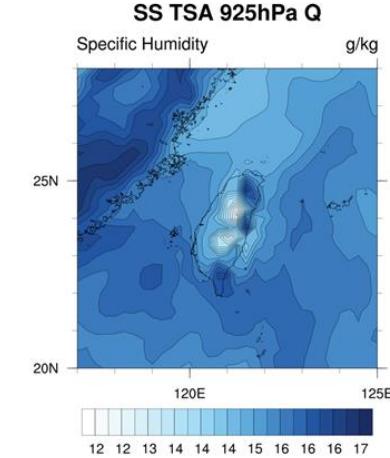
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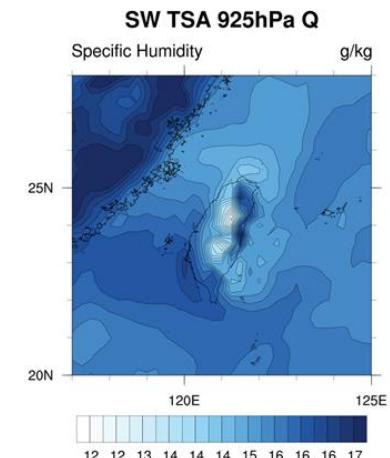
SE



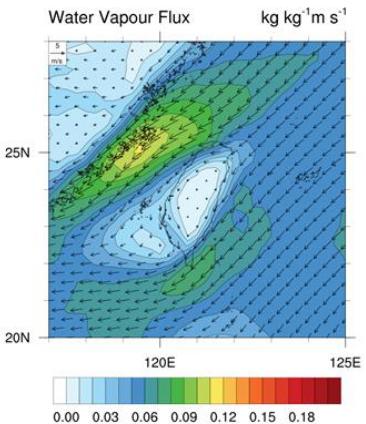
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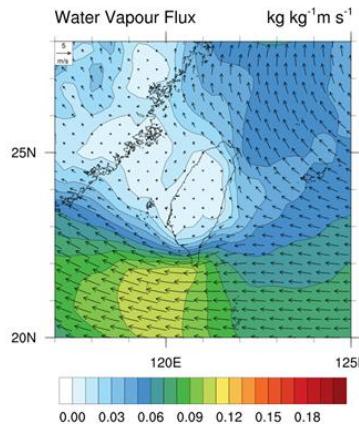
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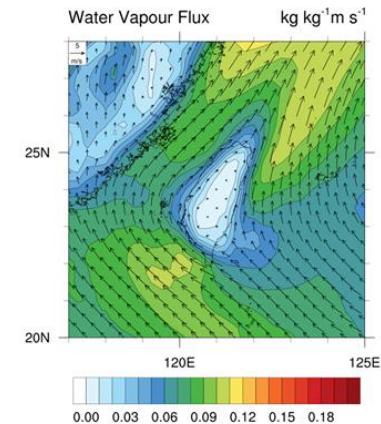
NE TSA 925hPa Water Vapour Flux



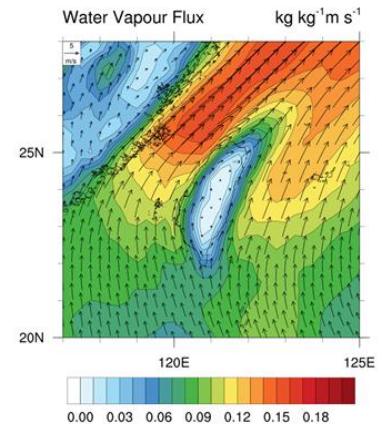
EE TSA 925hPa Water Vapour Flux



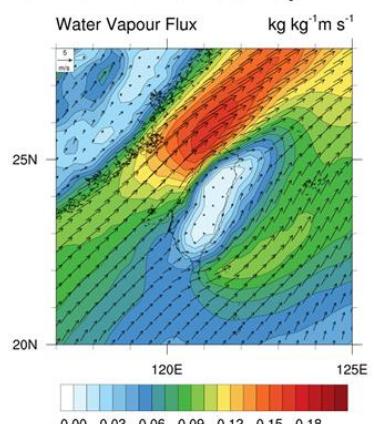
SE TSA 925hPa Water Vapour Flux



SS TSA 925hPa Water Vapour Flux



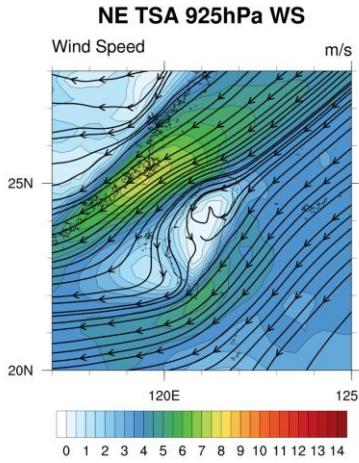
SW TSA 925hPa Water Vapour Flux



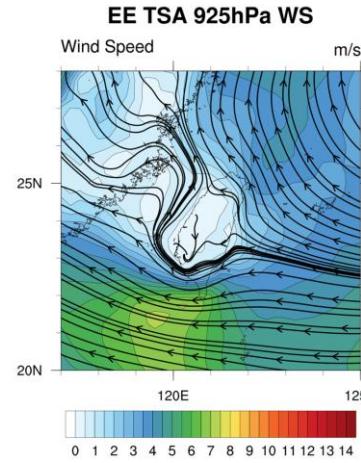
# Result – TSA synoptic analysis

925hPa Wind Speed (m/s) & Streamline  
 ↑ : TSA   ↓ : noTSA

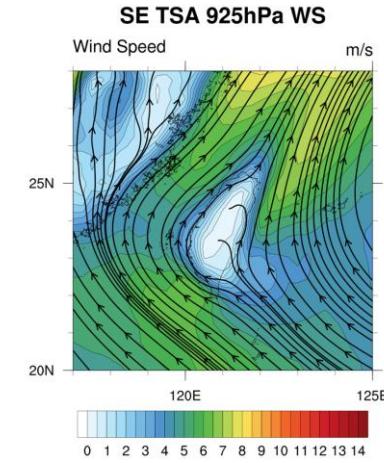
NE



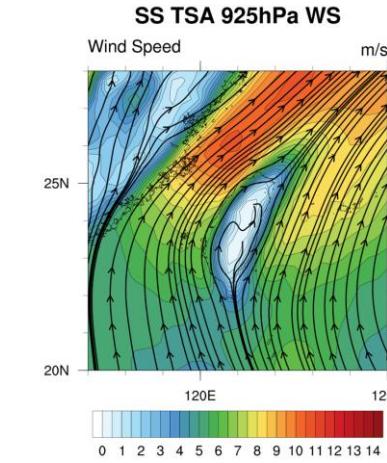
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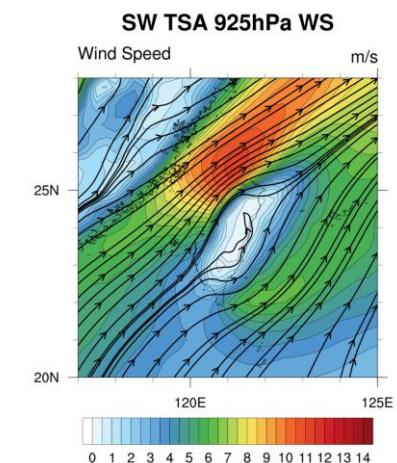
SE



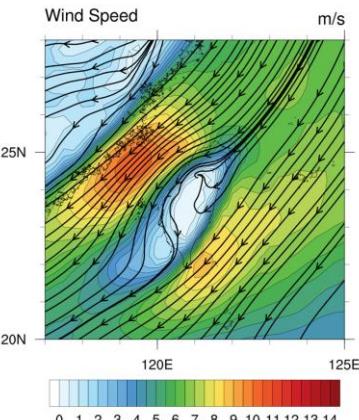
SS



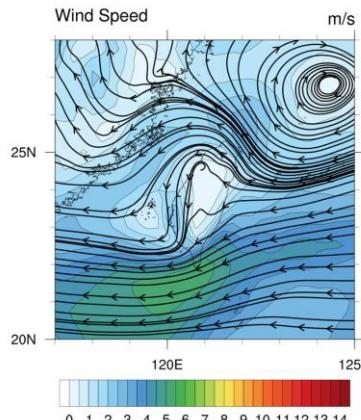
SW



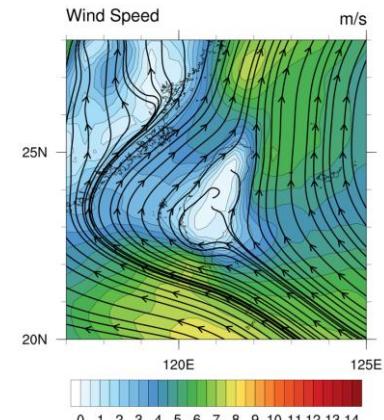
NE noTSA 925hPa WS



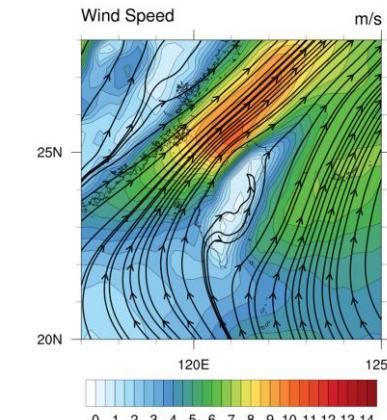
EE noTSA 925hPa WS



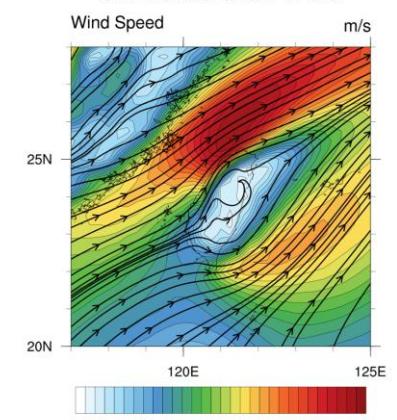
SE noTSA 925hPa WS



SS noTSA 925hPa WS



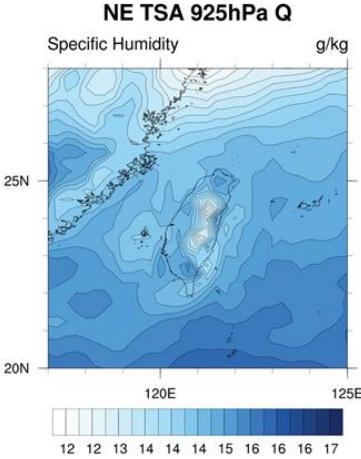
SW noTSA 925hPa WS



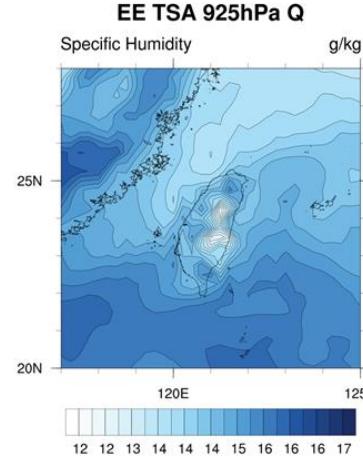
# Result – TSA synoptic analysis

↑ : 925hPa Specific Humidity (g/kg)  
 ↓ : 925hPa Wind Speed (m/s) & Streamline

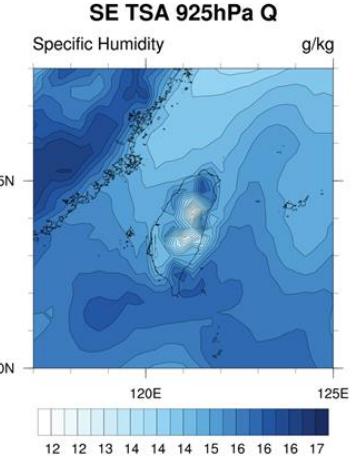
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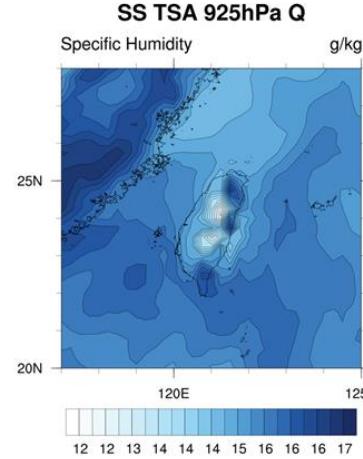
EE



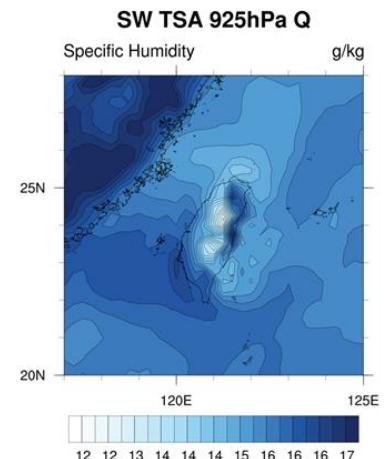
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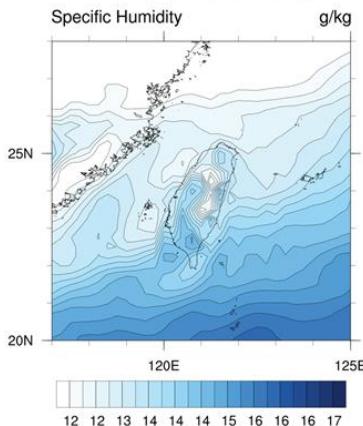
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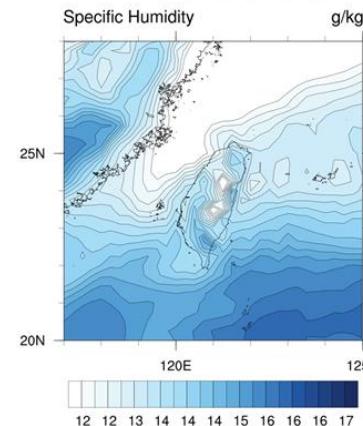
SW



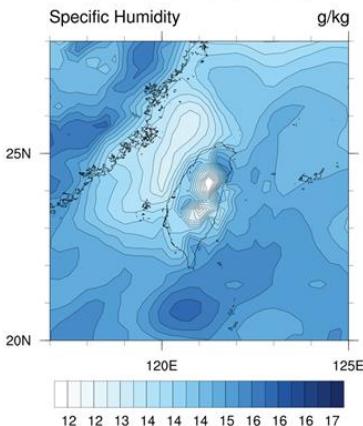
NE noTSA 925hPa Q



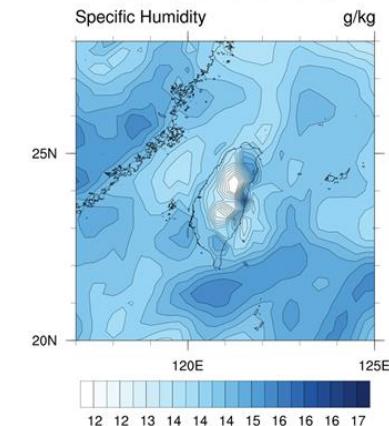
EE noTSA 925hPa Q



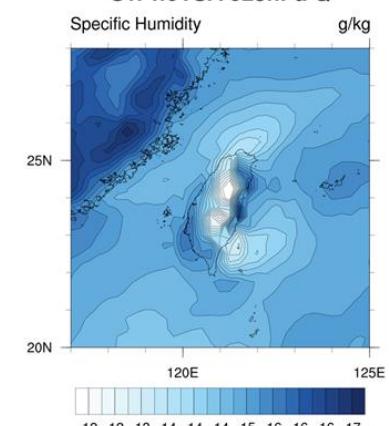
SE noTSA 925hPa Q



SS noTSA 925hPa Q



SW noTSA 925hPa Q



# Result – TSA vs noTSA surface analysis

NE

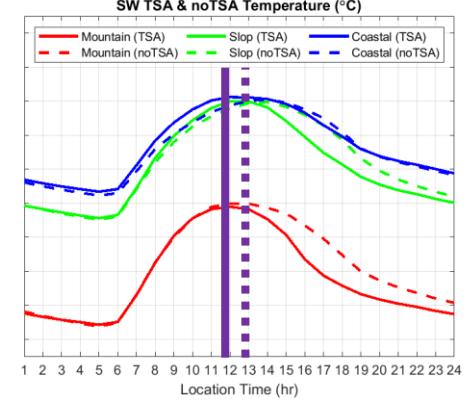
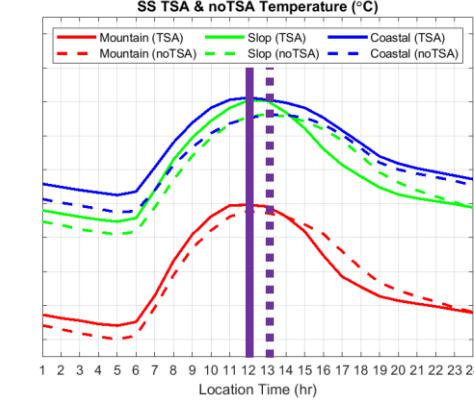
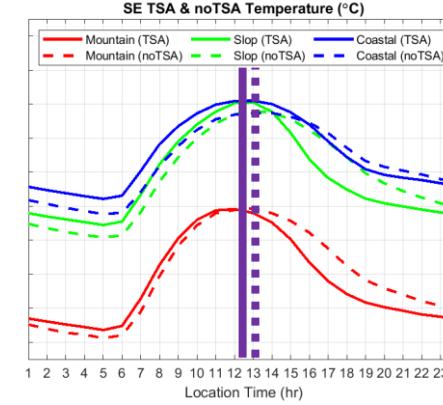
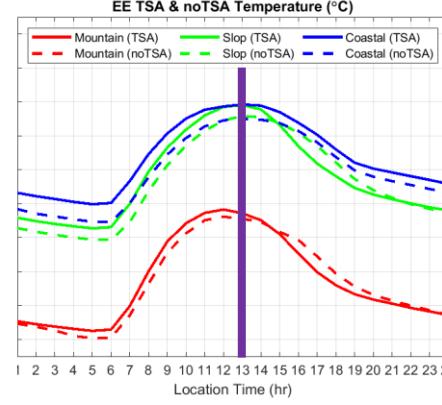
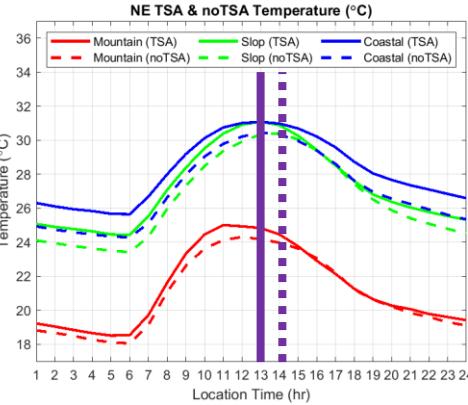
EE

SE

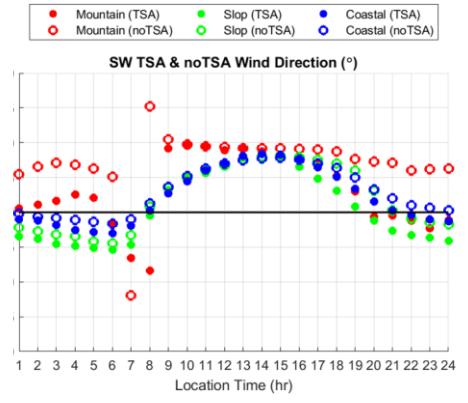
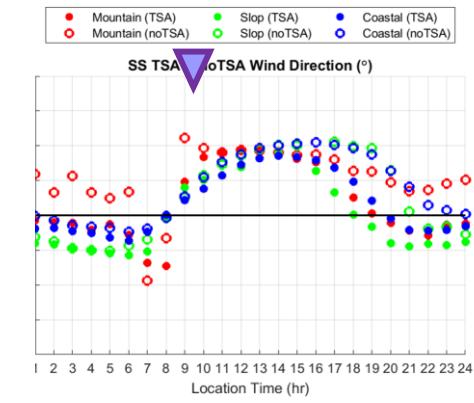
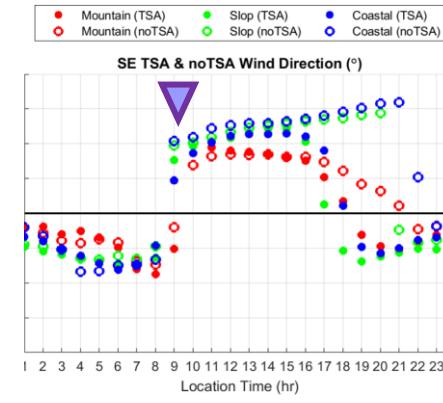
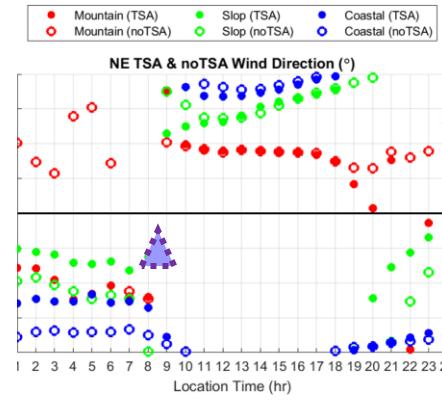
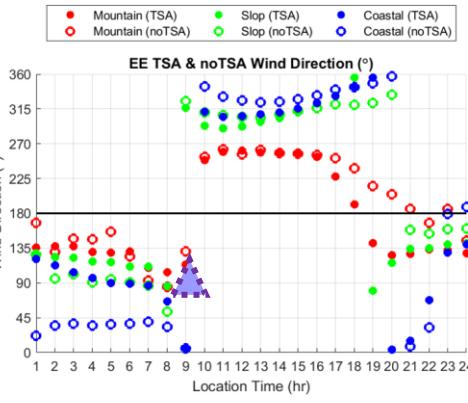
SS

SW

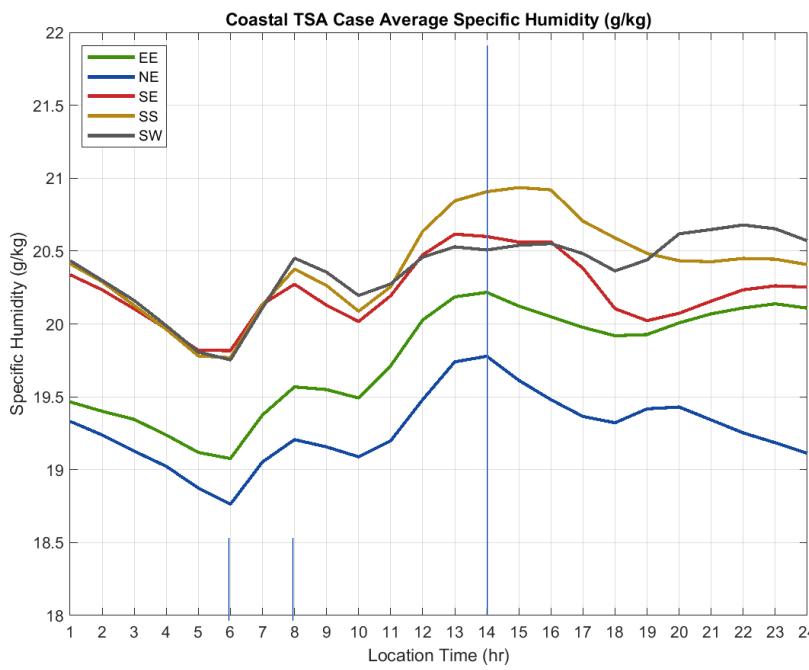
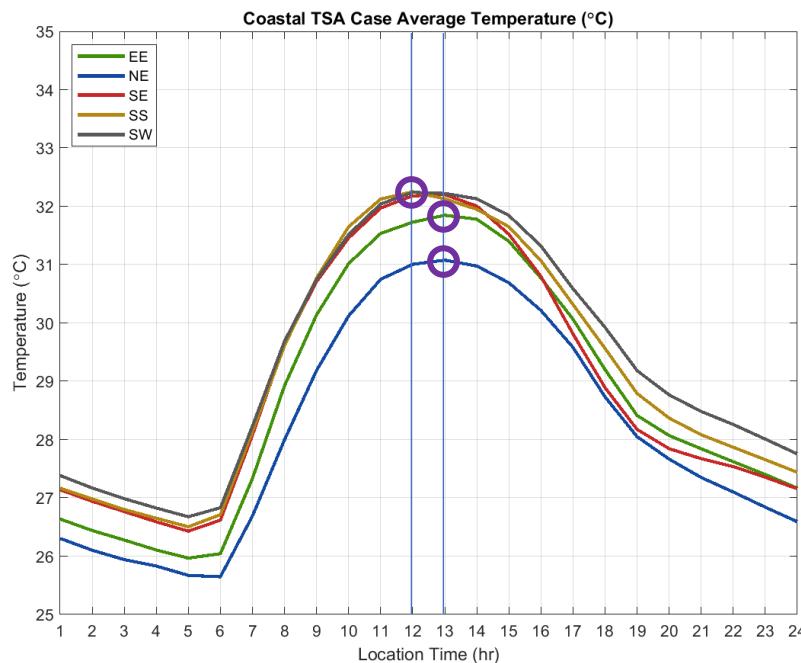
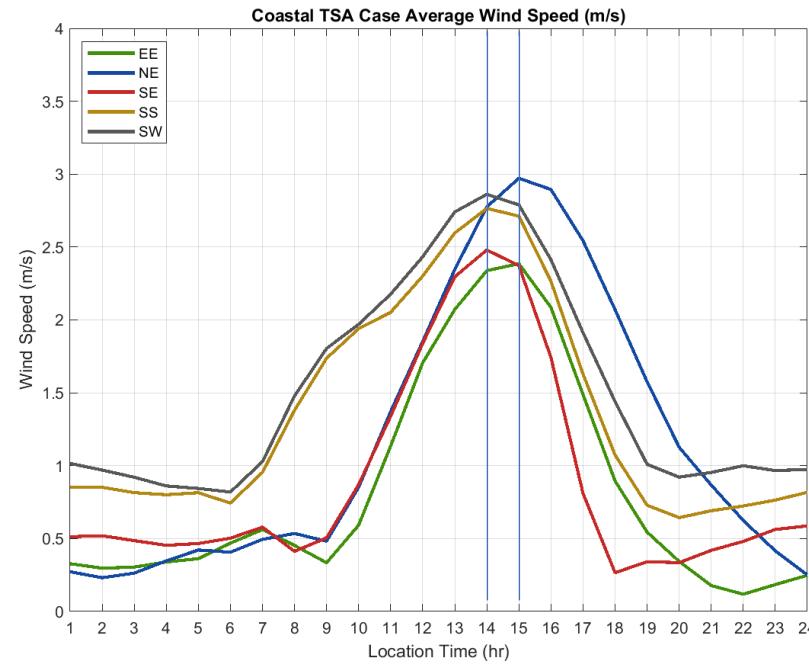
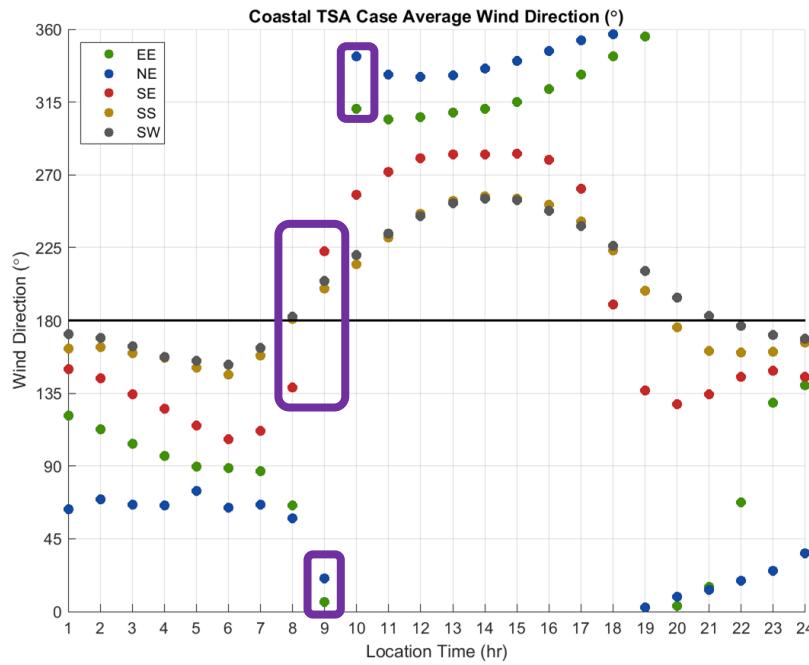
T



V



除了EE，結果與Chen et al. (2016)相似



# TSA

- 溫度增溫幅度
- 海陸風風向風速
- 水氣傳輸

# Result – TSA vs noTSA stability analysis

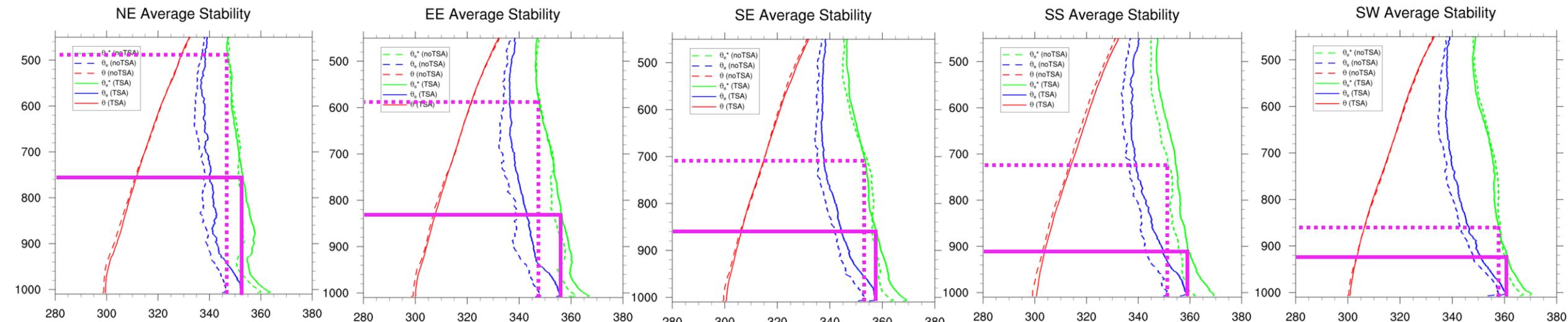
NE

EE

SE

SS

SW



| 風場<br>變數                               | NE    |       | EE    |       | SE    |       | SS    |       | SW     |       |
|--|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|
|  | TSA   | noTSA | TSA   | noTSA | TSA   | noTSA | TSA   | noTSA | TSA    | noTSA |
| LCL (hPa)                              | 957.4 | 945.4 | 961   | 946.8 | 955.8 | 959.2 | 961.8 | 963.2 | 964.4  | 964.6 |
| LFC (hPa)                              | 877.3 | 870.9 | 890.4 | 777.5 | 876.2 | 834   | 900.9 | 825.2 | 911.8  | 884.6 |
| CAPE (m <sup>2</sup> /s <sup>2</sup> ) | 497.7 | 180.6 | 622.1 | 150.3 | 814.4 | 306.4 | 664.2 | 414.8 | 1185.2 | 625.5 |
| CIN (m <sup>2</sup> /s <sup>2</sup> )  | 42.7  | 54.7  | 27.9  | 114.4 | 33    | 59.5  | 20.1  | 58.9  | 18.5   | 33.7  |
| QPF (kg/m <sup>2</sup> )               | 51    | 45.9  | 51.7  | 43.7  | 51.5  | 48    | 54.5  | 46.5  | 52.8   | 48.6  |

# Result – TSA vs noTSA stability analysis

| 風場<br>變數           | NE     |        | EE     |        | SE     |        | SS     |        | SW     |        |
|--------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                    | TSA    | noTSA  |
| LCL (hPa)          | 961.34 | 945.10 | 958.84 | 950.67 | 957.00 | 957.49 | 957.02 | 958.19 | 956.84 | 958.54 |
| LFC (hPa)          | 753.29 | -      | 794.05 | 576.83 | 827.44 | 677.95 | 843.45 | 701.99 | 846.43 | 691.85 |
| EL (hPa)           | 752.52 | -      | 793.77 | 576.72 | 826.76 | 677.72 | 843.20 | 700.64 | 845.29 | 691.13 |
| CAPE ( $m^2/s^2$ ) | 0.0055 | -      | 0.0011 | 0.0004 | 0.0029 | 0.0008 | 0.0007 | 0.0178 | 0.0106 | 0.0061 |
| CIN ( $m^2/s^2$ )  | 55.89  | -      | 48.10  | 217.27 | 44.37  | 125.25 | 34.72  | 82.64  | 33.39  | 86.96  |
| QPF ( $kg/m^2$ )   | 49.57  | 44.78  | 49.60  | 41.11  | 51.80  | 47.25  | 53.56  | 48.30  | 53.15  | 47.24  |

# Result – TSA vs noTSA stability analysis

| 風場<br>變數 | NE    |       | EE    |       | SE    |       | SS    |       | SW    |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|          | TSA   | noTSA |
| KI       | 30.00 | 25.50 | 30.10 | 22.00 | 30.40 | 27.20 | 30.70 | 28.80 | 30.30 | 26.20 |
| TTI      | 41.20 | 37.90 | 42.50 | 38.60 | 42.80 | 42.40 | 42.90 | 42.20 | 42.30 | 40.40 |
| LI       | -5.27 | -1.35 | -8.07 | -2.13 | -8.29 | -7.24 | -8.60 | -7.45 | -8.65 | -6.66 |