

臺灣極端高溫事件之 區域特性及其大氣環流型態分析

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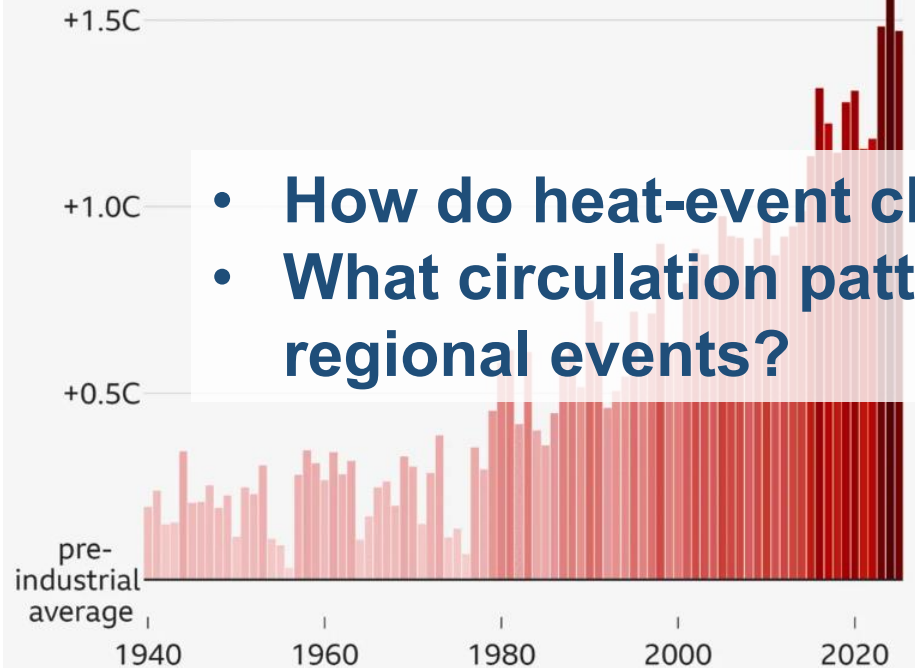
中研院 環境變遷中心 ³



Escalating Heat Extremes from Global Warming to Taiwan's Regional Hotspots

Last three years were hottest on record

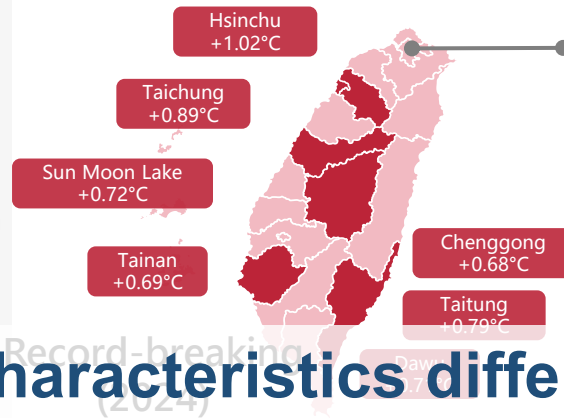
Global average temperature by year, compared with the pre-industrial average (1850-1900)



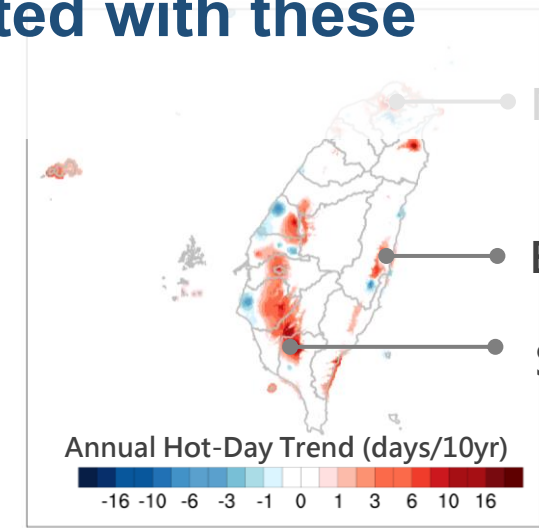
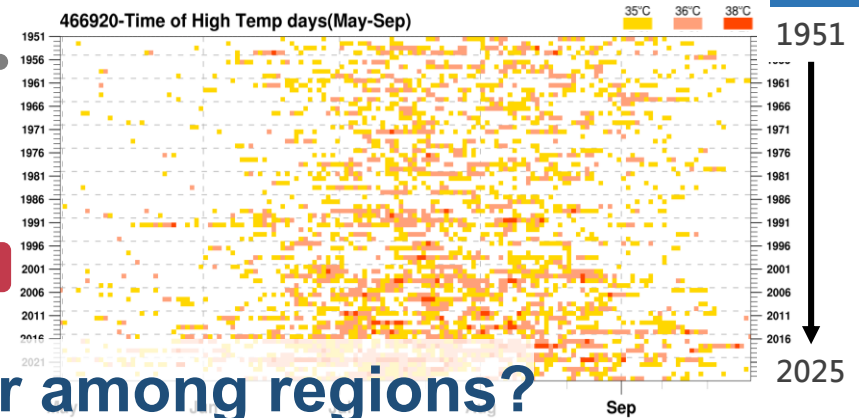
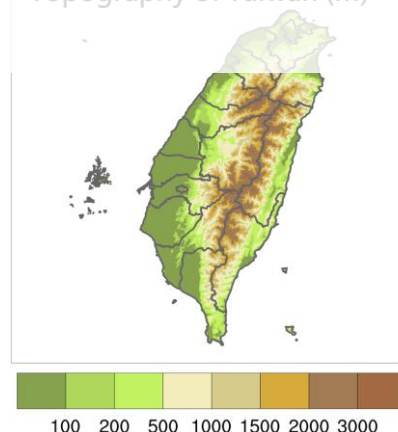
Source: ERA5, C3S/ECMWF

BBC

- How do heat-event characteristics differ among regions?
- What circulation patterns are associated with these regional events?



Topography of Taiwan (m)

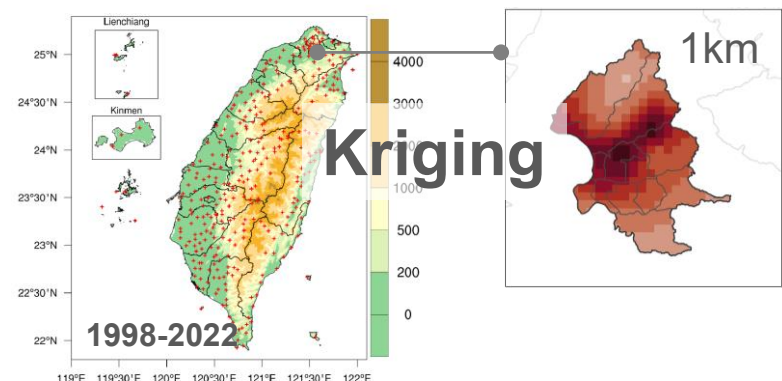


- Northern Taiwan
雙北地區
- Eastern Taiwan
東部縱谷地區
- Southern Taiwan
淺山區



Data and Method

TaiSA
Taiwan Station-based Analysis dataset



Tmax

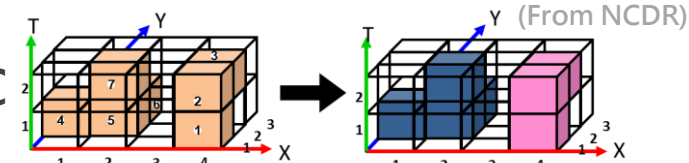
Data

Event

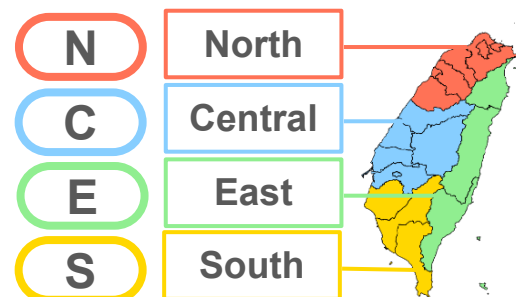
Detection

Lo et al. (2021)

$\geq 35^{\circ}\text{C}$



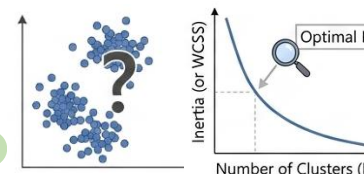
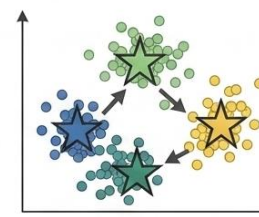
Regional Heat event



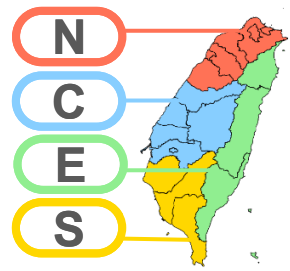
ERA5

H500 | MSLP | UV850 | q850

K-means clustering
Elbow analysis

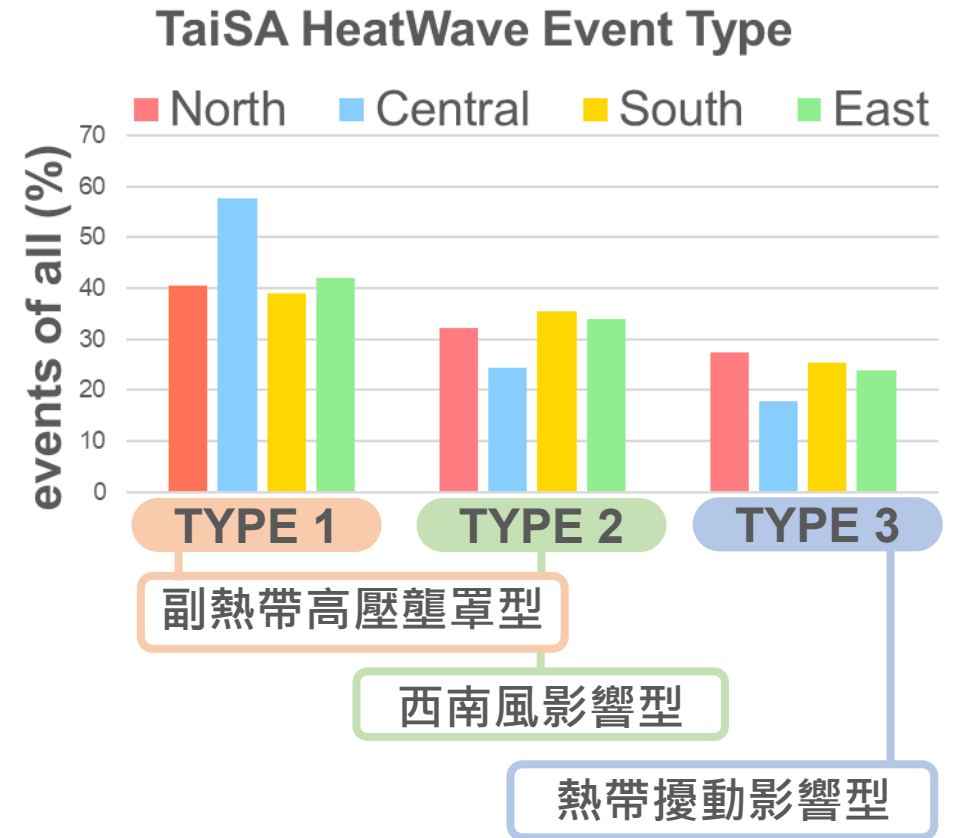
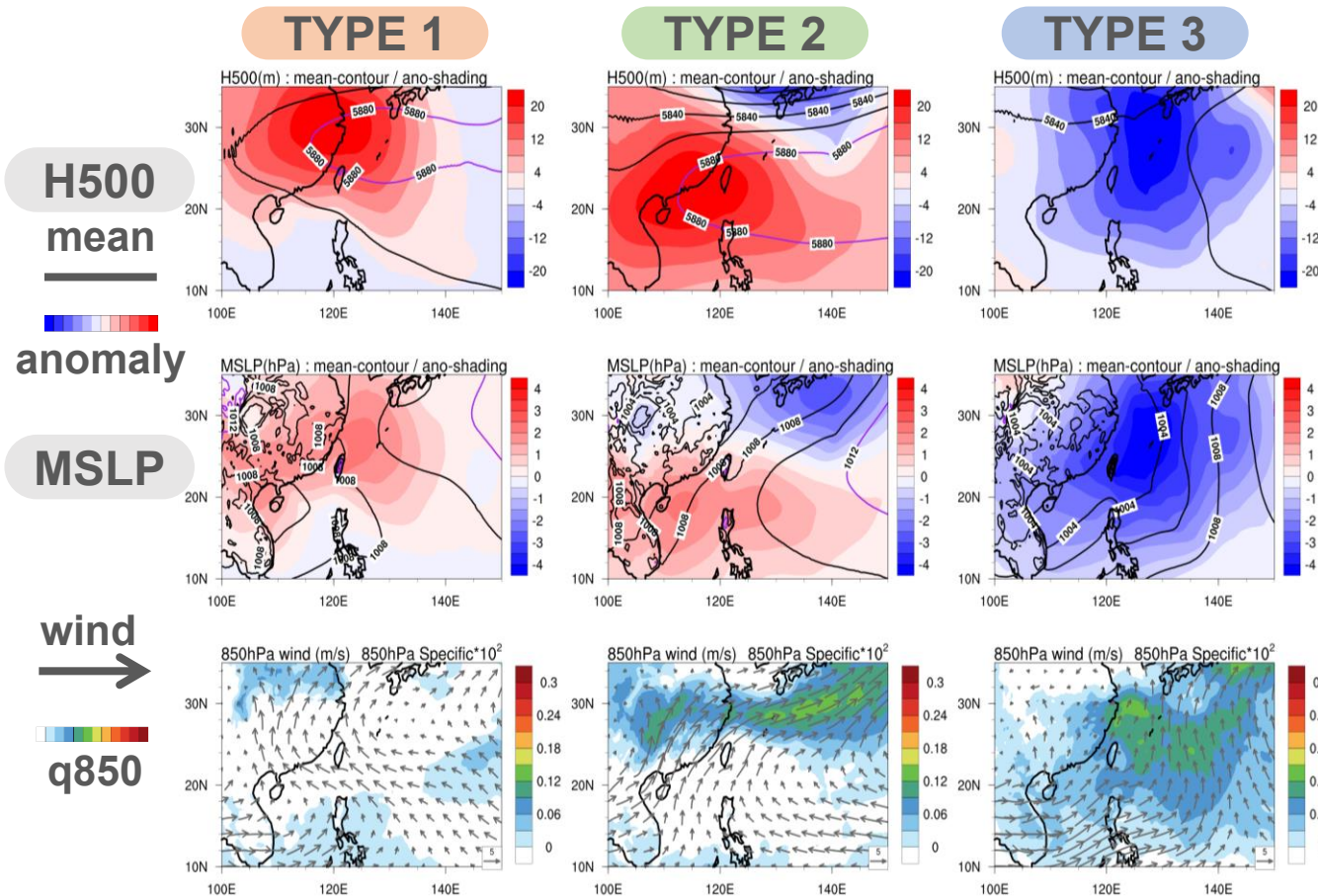


HWMA 平均面積	Mean area of the heatwave event
HWMM 平均強度	Mean magnitude of the heatwave event
HWD 事件延時	Duration of the heatwave event in days
HWMS HWD*HWMA*HWMM 事件等級	Heatwave magnitude scale

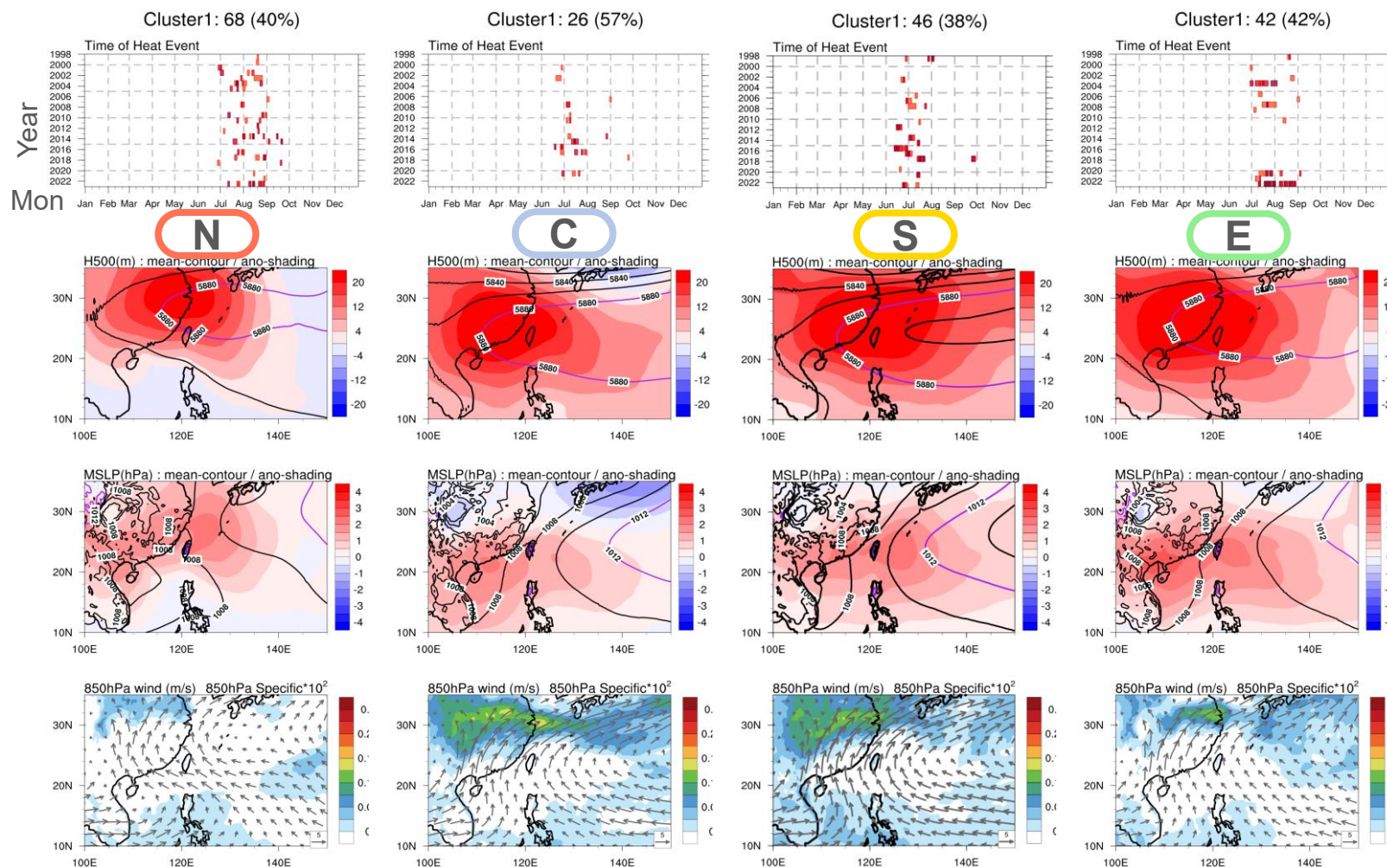
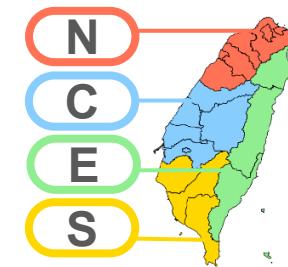


Circulation Regimes of Regional heat events

K-means clustering identifies three dominant circulation environments.



TYPE 1 副熱帶高壓影響型



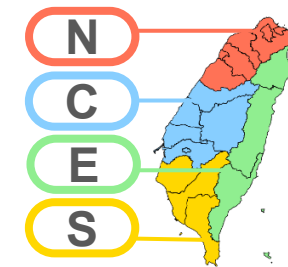
N E
Jul.-Aug.

主要發生時間集中在夏季7-8月，呈現有較偏北的副熱帶高壓環境

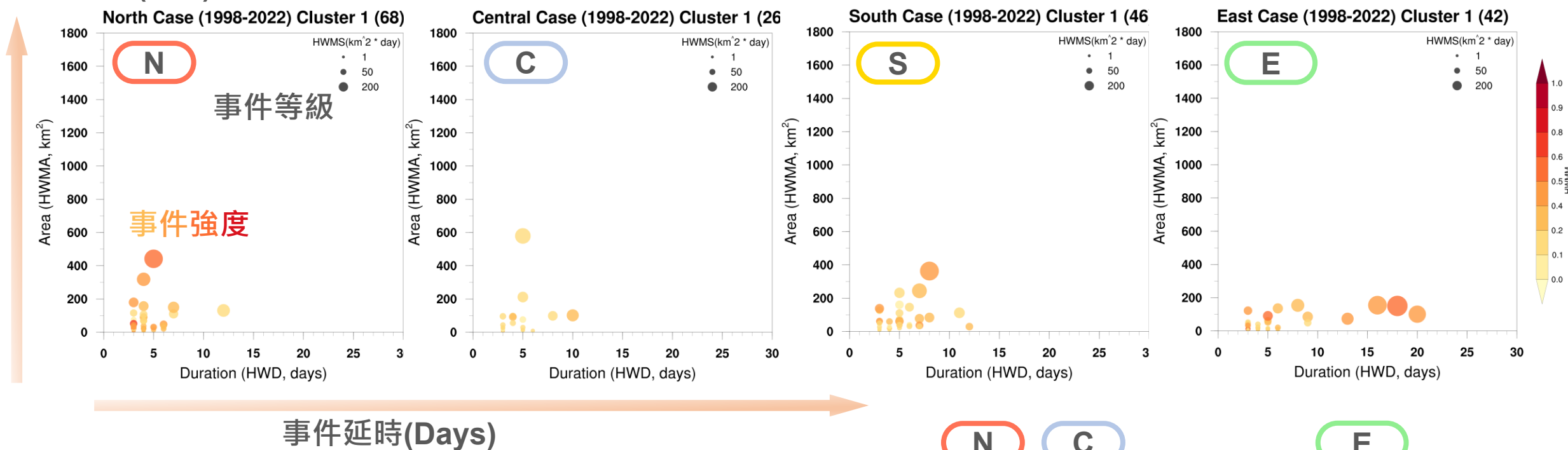
C S
Jun.-Jul.

發生於時間上對較早的6-7月，呈現較偏南且西擴的副熱帶高壓分布

TYPE 1 副熱帶高壓影響型



事件面積 (km²)



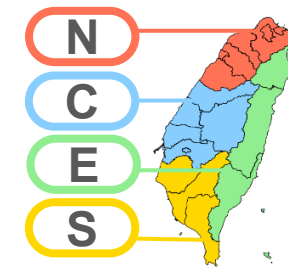
事件延時(Days)

Under the same synoptic background
→ local topography and regional circulation
→ modulate the characteristics of heat events.

N C
事件短延時

E
區域型事件、時間延時長

S
事件特質較平均

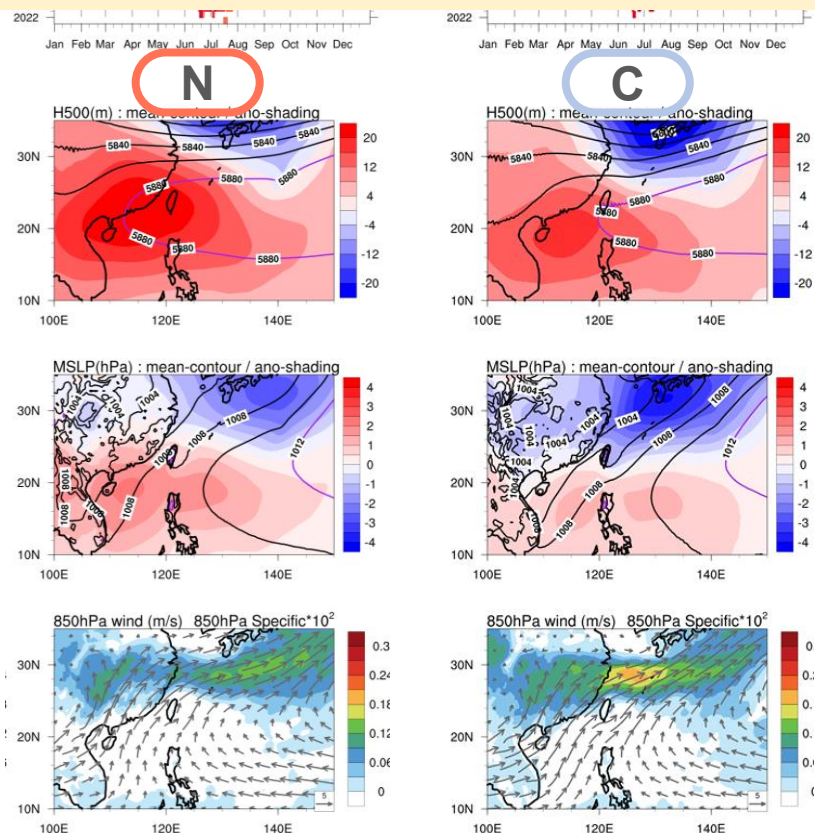


TYPE 2 西南風影響型

Cluster2: 54 (32%)

Cluster2: 34 (34%)

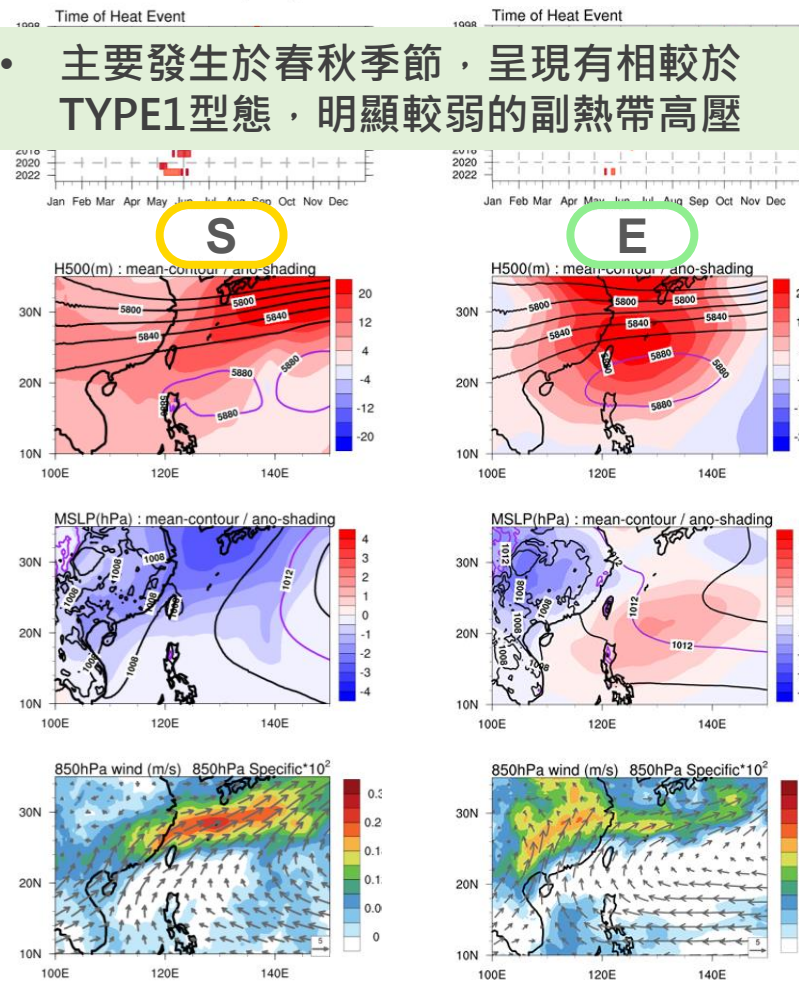
- 相較於TYPE1型態，大環境場副熱帶高壓位置較偏南、西擴
- 處於較濕熱的情境

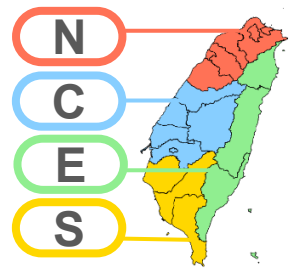


Cluster3: 28 (23%)

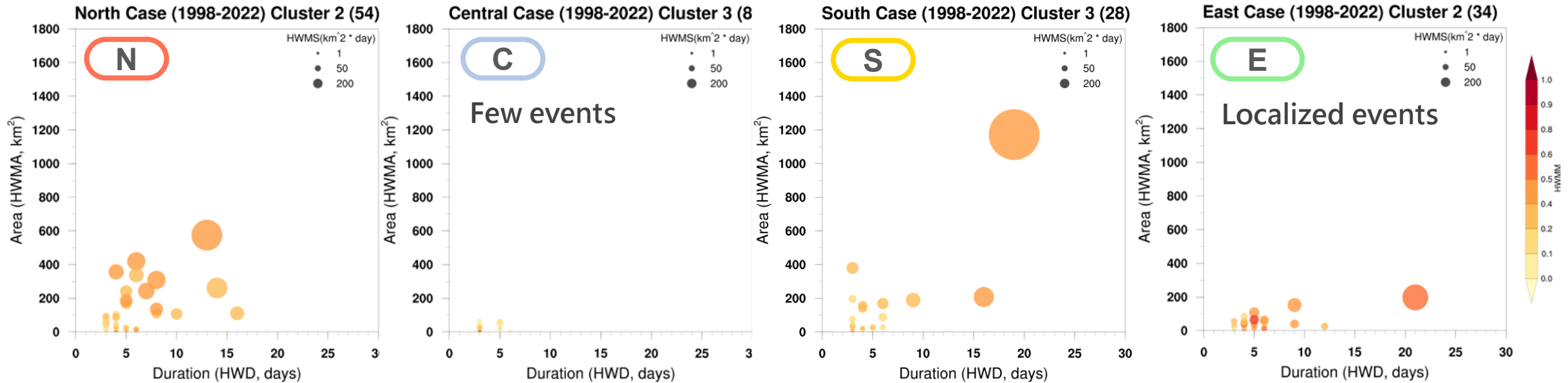
Cluster3: 8 (17%)

- 主要發生於春秋季節，呈現有相較於TYPE1型態，明顯較弱的副熱帶高壓



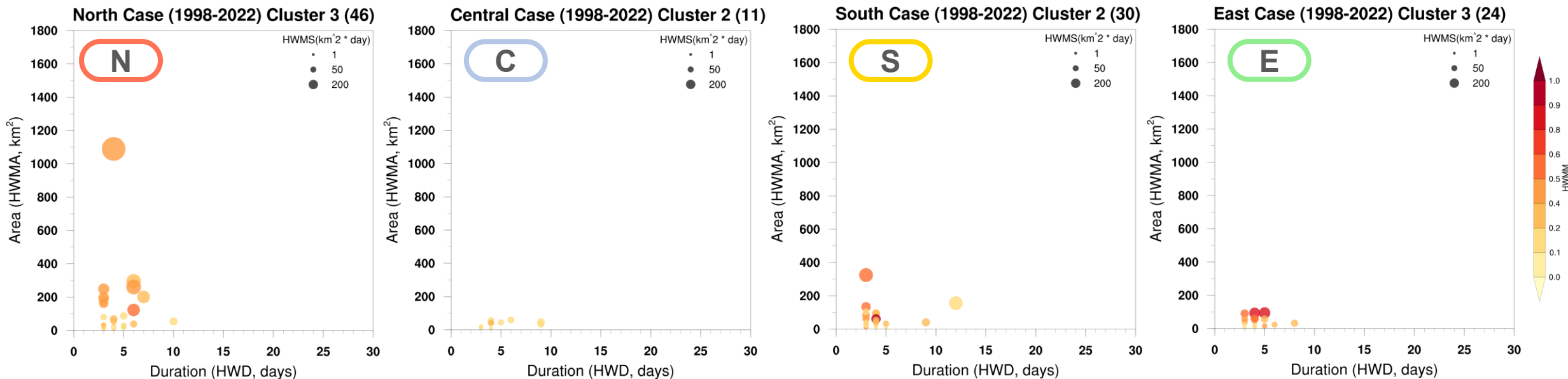
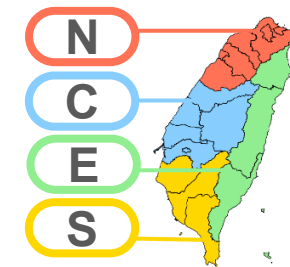


TYPE 2 西南風影響型



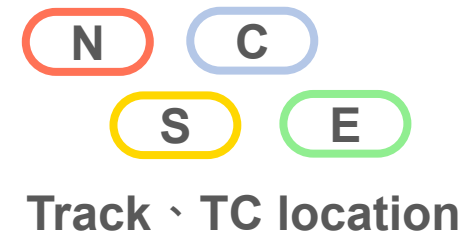
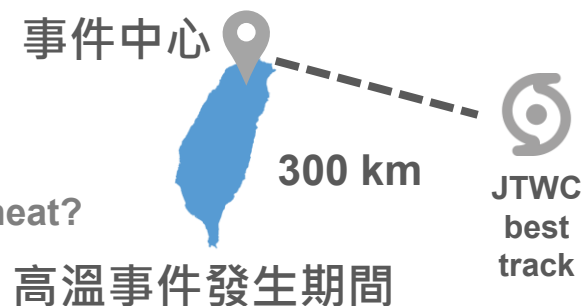
Overall, Type 2 shows stronger regional and seasonal contrasts than Type 1

TYPE 3 熱帶擾動影響型

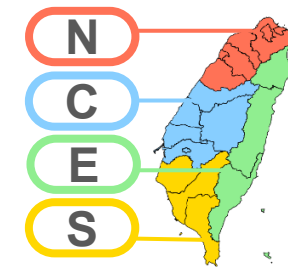


TC-related event identification

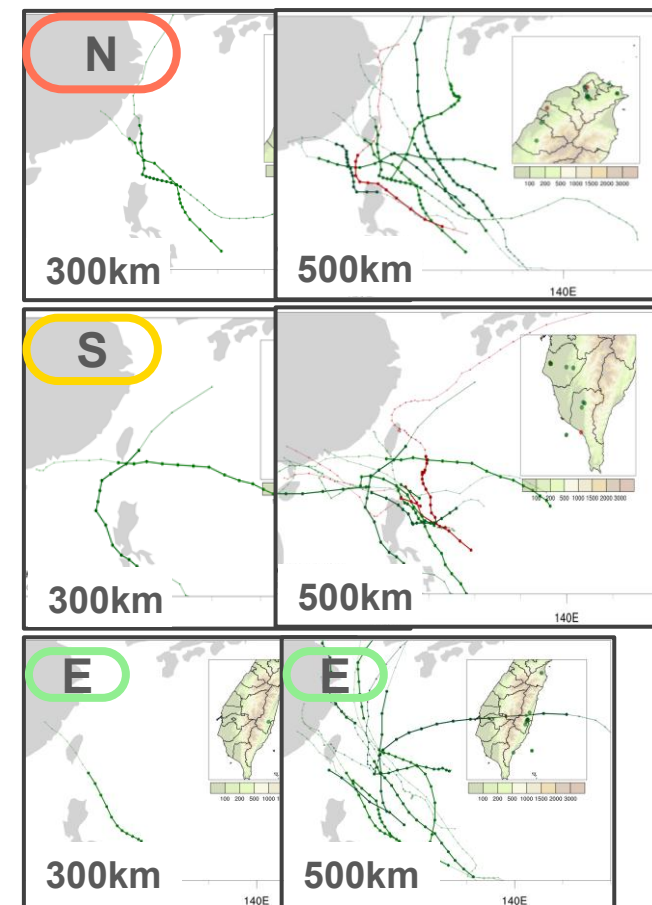
K-means composites → low-pressure signals near Taiwan.
Can composite low-pressure signals directly indicate TC-related heat?



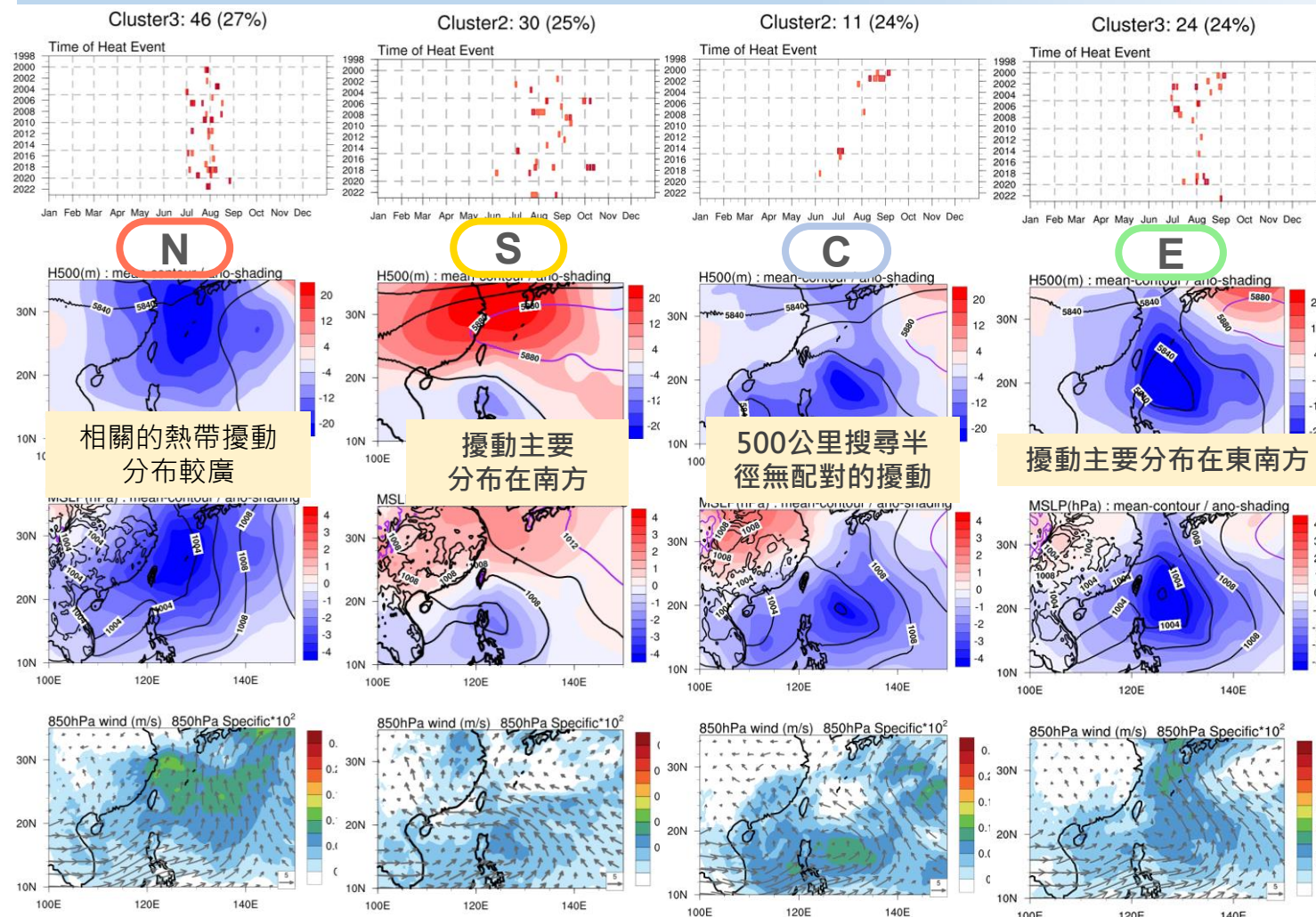
TYPE 3 熱帶擾動影響型



Selected tracks from JTWC



Locations with heat event dates Overlap
Tracks of the matched systems





Conclusion and Discussion

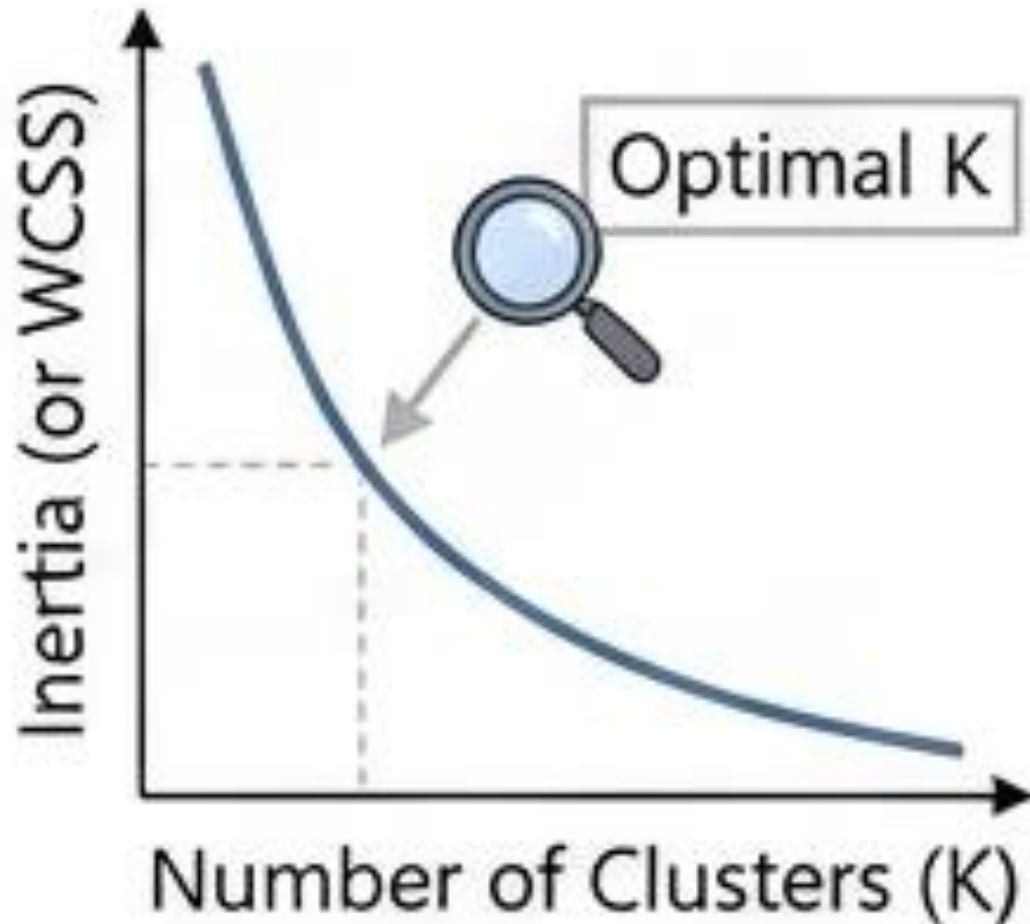
- ☀️ **Extreme heat in Taiwan is not a single-process hazard: regional hotspots emerge from the interaction between warming background, synoptic circulation and terrain.**
- ☀️ **Three dominant circulation patterns were identified:**
 - TYPE 1 — 副熱帶高壓影響型
 - TYPE 2 — 西南風影響型
 - TYPE 3 — 熱帶擾動影響型
- ☀️ **The duration, affected area, magnitude, and event scale show regional differences**
 - ☁️ North / Central : 多數是件短延時、面積小
 - ☁️ South : 事件特徵多元，事件延時、面積、強度及等級等特徵分布較分散
 - ☁️ East : 區域型的事件、且持續時間長
- ☀️ **The mechanisms behind these regional heat events that causing these different characteristics.**
- ☀️ **Specific distance that influence the tropical-system-related heat event in different regions.**

Thanks for your listening

backup



Elbow Analysis



- We used the elbow analysis to determine the optimal number of clusters.
- We test different value of K and calculated the total distance from the cluster center for each one.
- As the number of cluster increase, the total distance should be decrease.
- We then select the point where the improvement starts to level off as the optimal number of clusters