利用MPAS區域模式探討山陀兒颱風(2024)滯留與消散機制

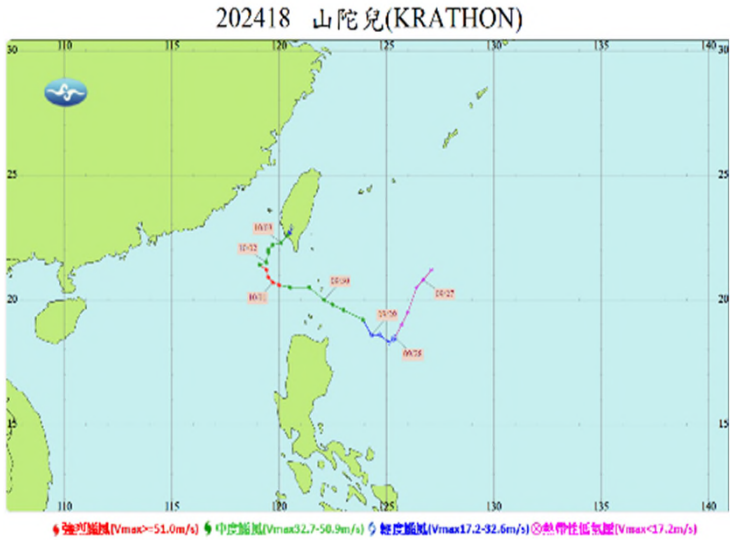
Investigation of the Stagnation and Dissipation Mechanisms of Typhoon Krathon (2024) Using the MPAS Regional Model

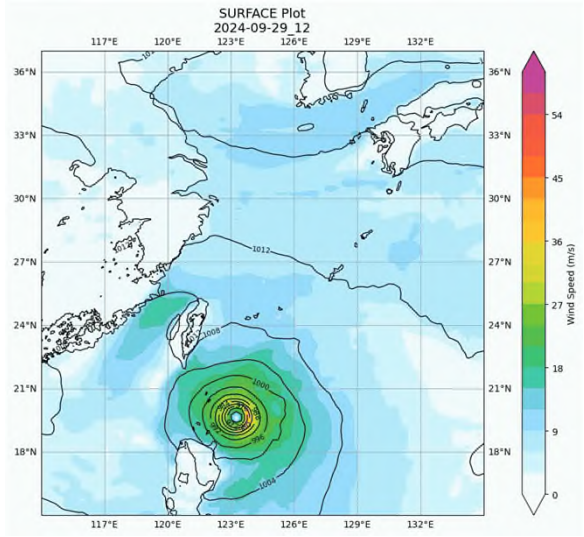
2025/09/02

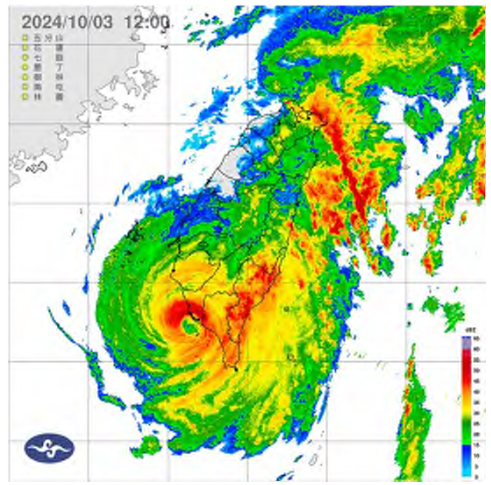
PRESENTED BY FANG-YU LIU (劉芳妤)

SUPERVISED BY PROF. CHING-YUANG HUANG (黃清勇)

INTRODUCTION





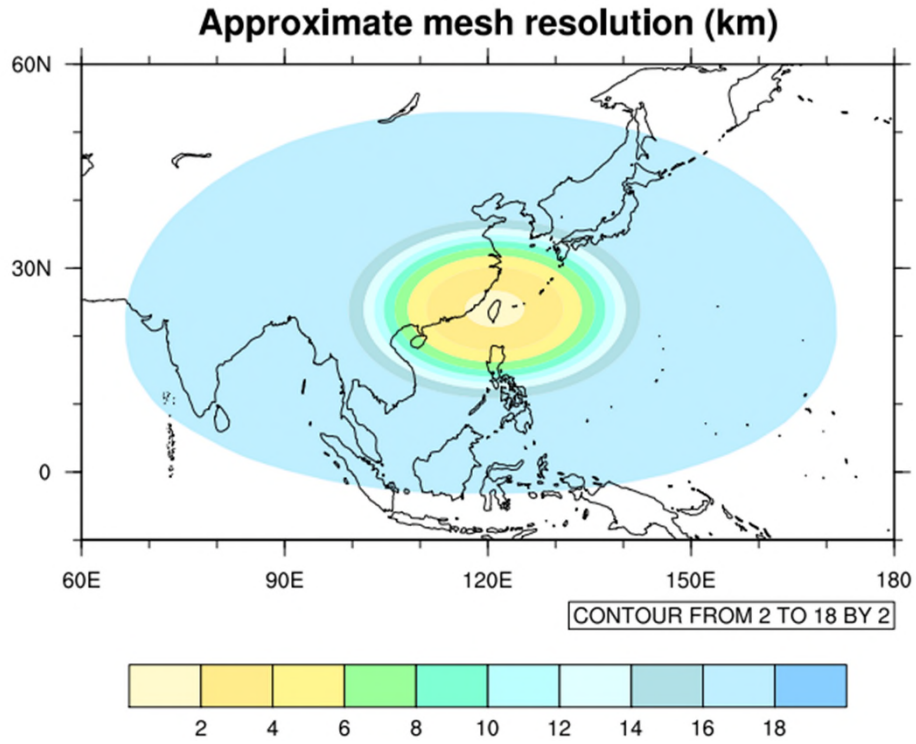


- 長時間滯留+路徑的高度不確定性 → 對高屏地區造成超乎預期的影響
- 登陸後環流快速消散→ 顯示地形與環境場對結構破壞的影響
- 中央大學颱風實驗室已成功透過MPAS對台灣周邊颱風進行模擬(2019利奇馬、2021燦樹)
  → 驗證MPAS在地形與颱風交互過程的優勢

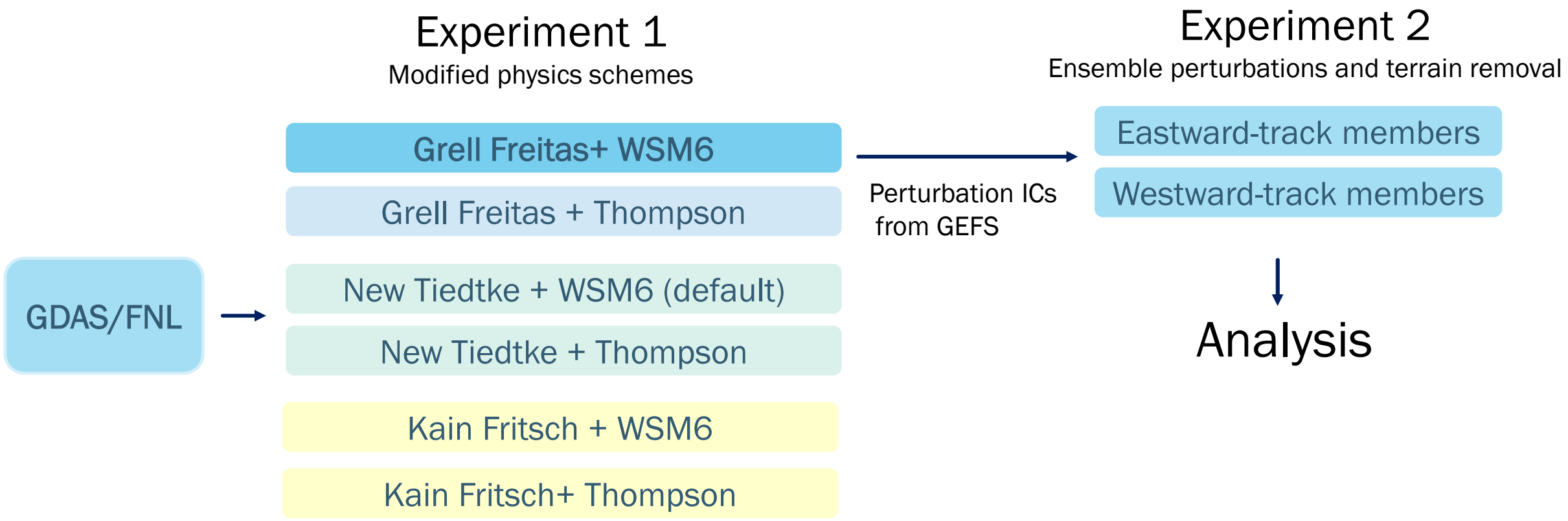
本研究採用 MPAS 區域模式模擬山陀兒颱風，
並著重探討地形與大尺度環流對其路徑與強度的影響。

MODEL

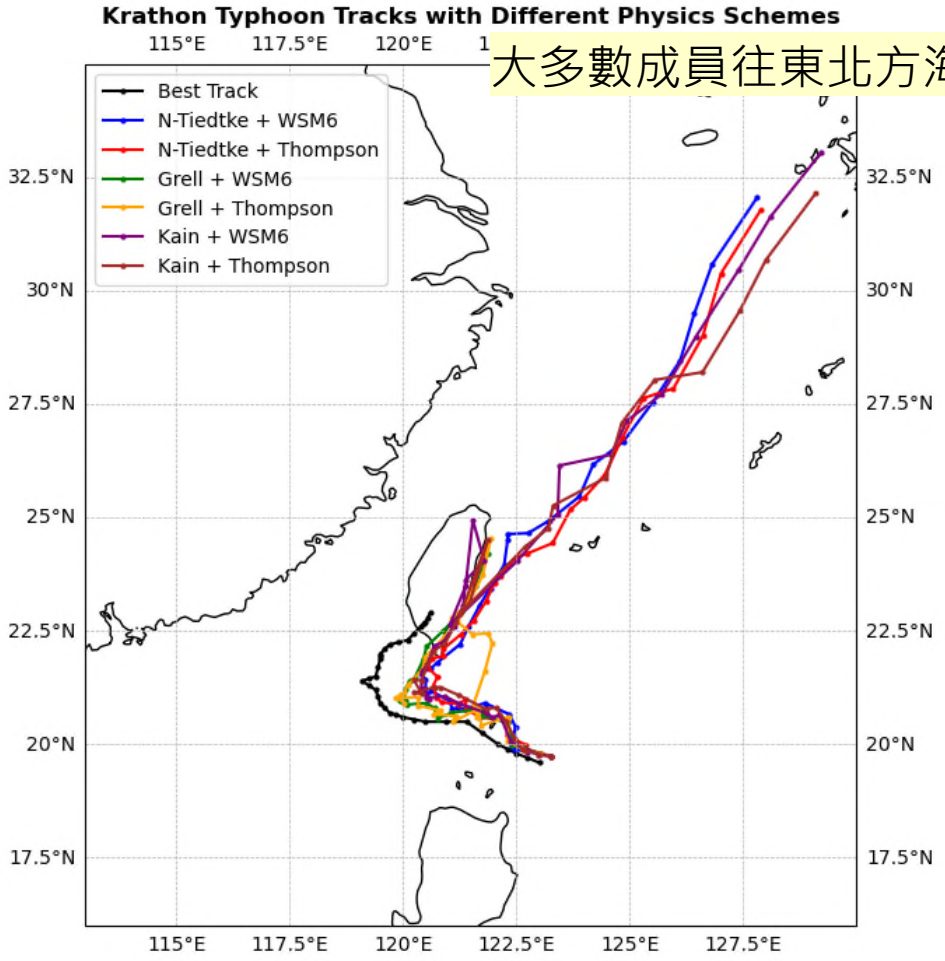
Reginal MPAS Version 8.0.1	
Simulation time	09/29 12 UTC ~ 10/03 18UTC, 102hrs
Resolution	20km – 2km
Physics suites	Mesoscale reference
Initial condition data	GDAS/FNL 0.25°×0.25° NOAA Global Ensemble Forecast System (GEFS) 0.5°×0.5°



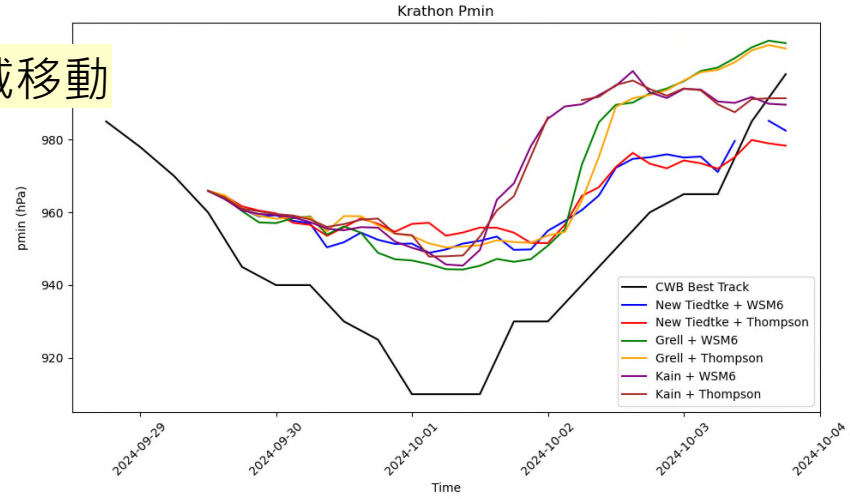
EXPERIMENT DESIGN

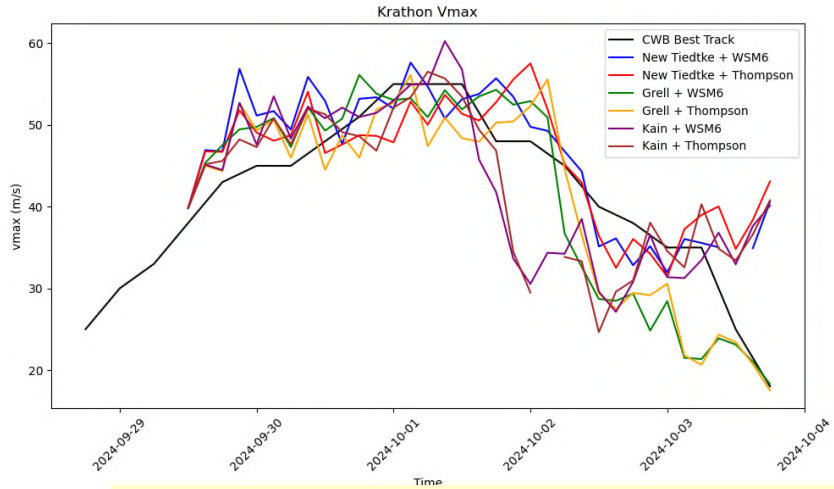


RESULTS – MODIFIED THE PHYSICS SCHEMES



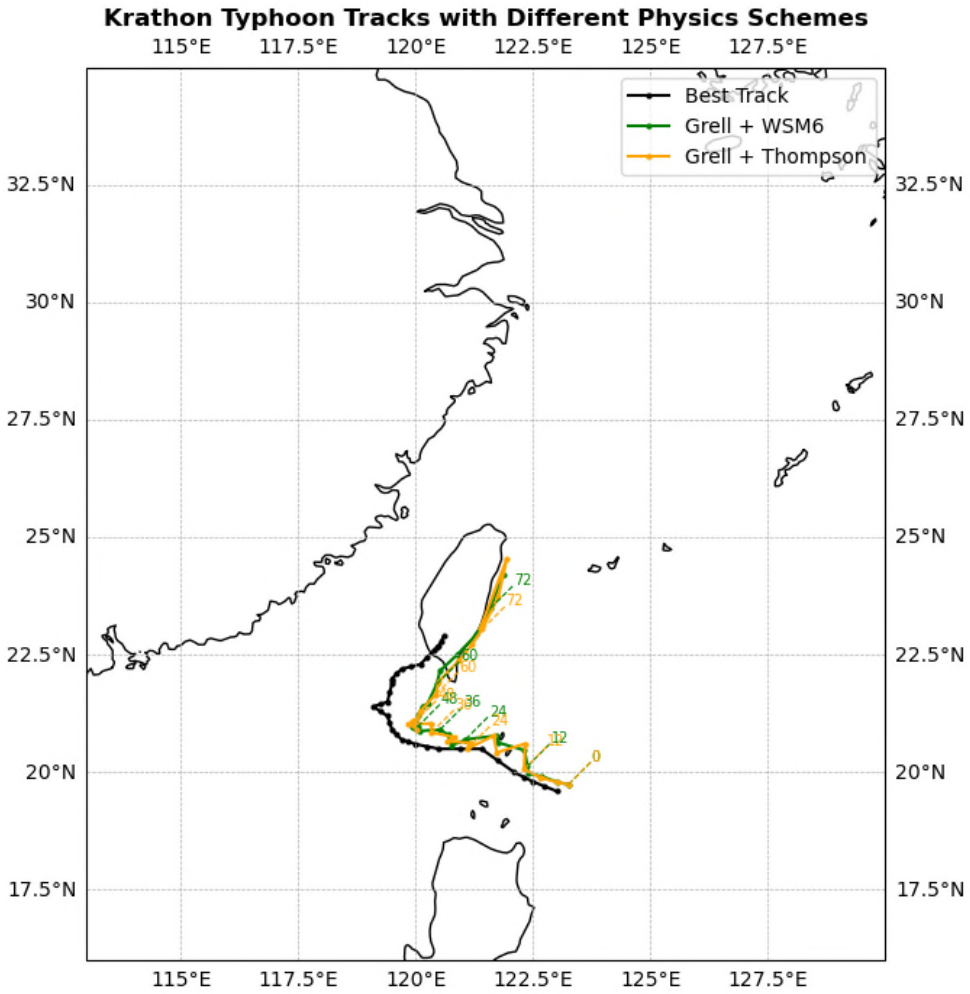
大多數成員往東北方海域移動

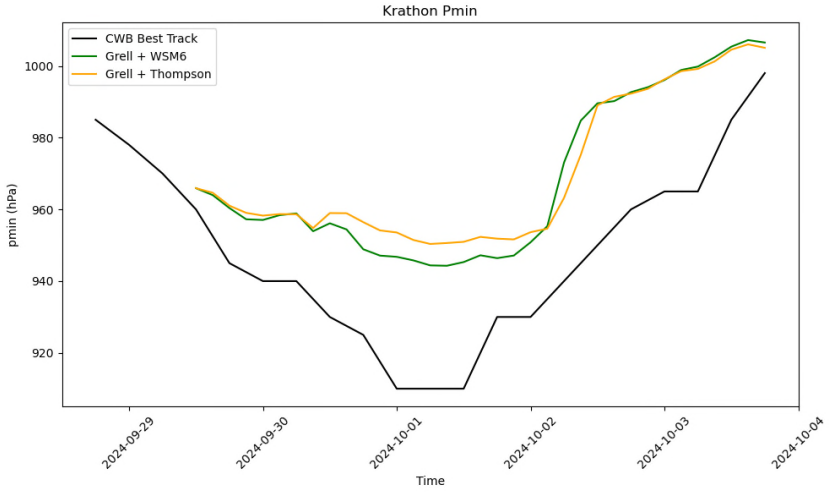


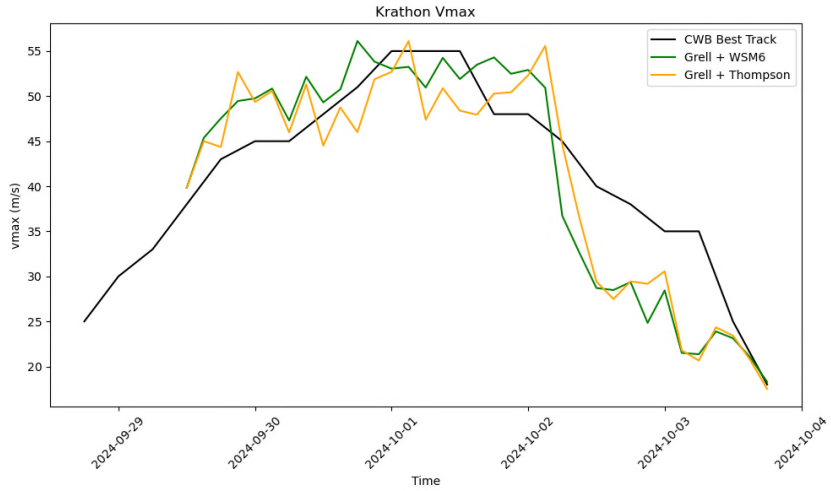


Convective schemes對模擬結果的影響較大

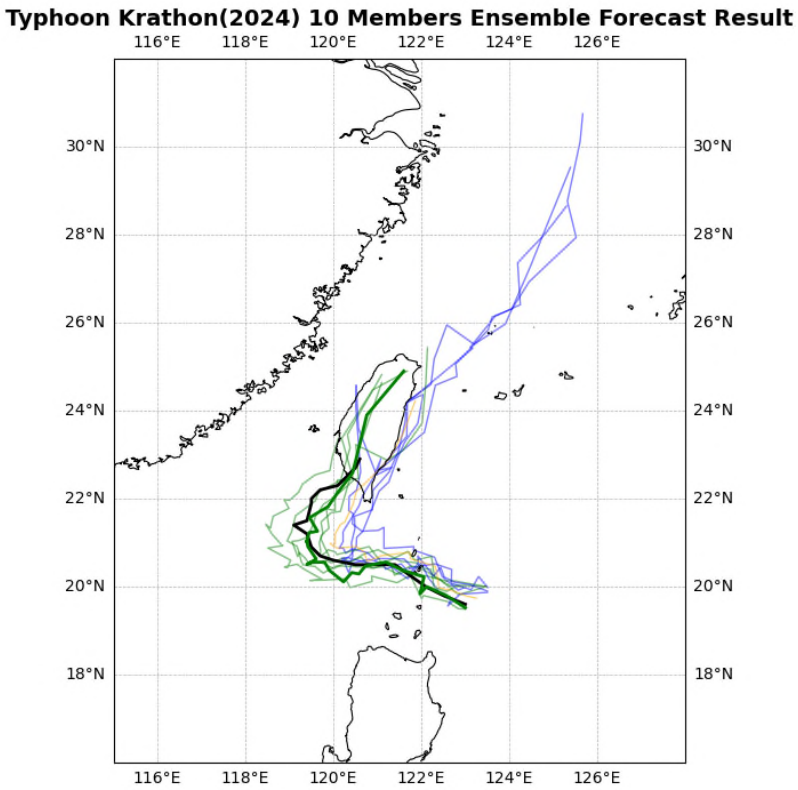
CONVECTION SCHEME- GRELL FREITAS

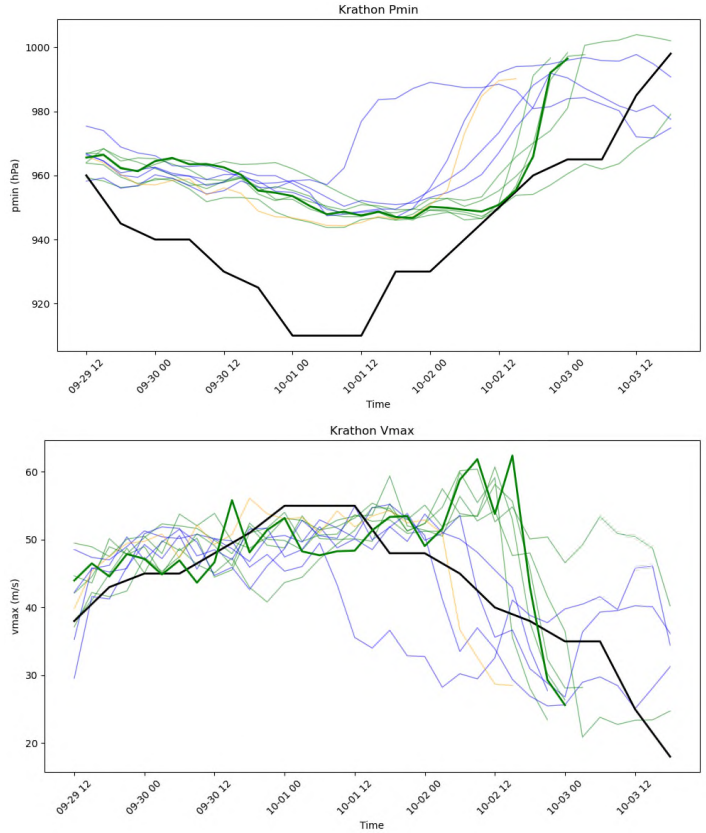




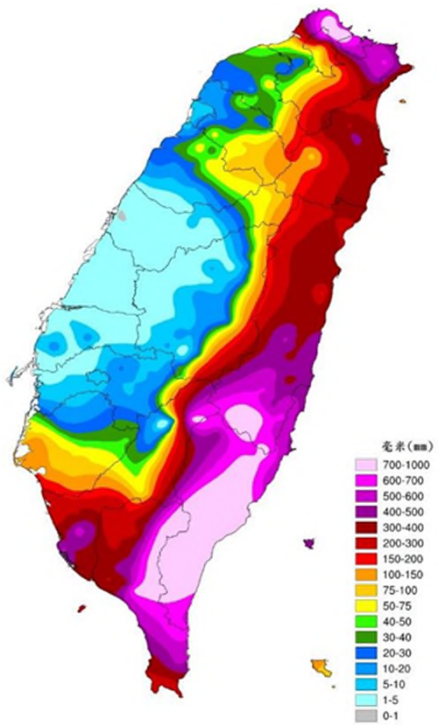


RESULTS - ENSEMBLE PERTURBATIONS

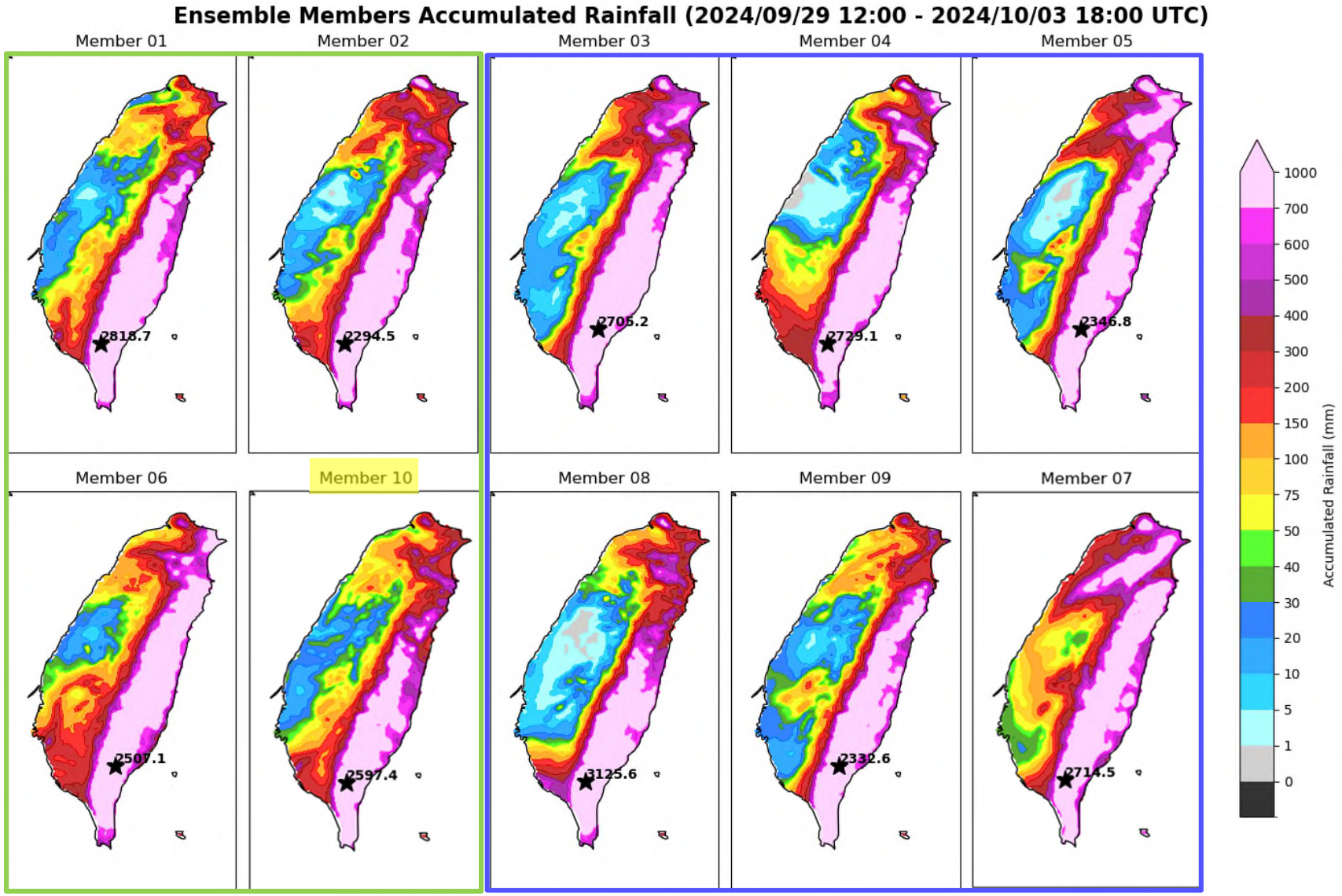




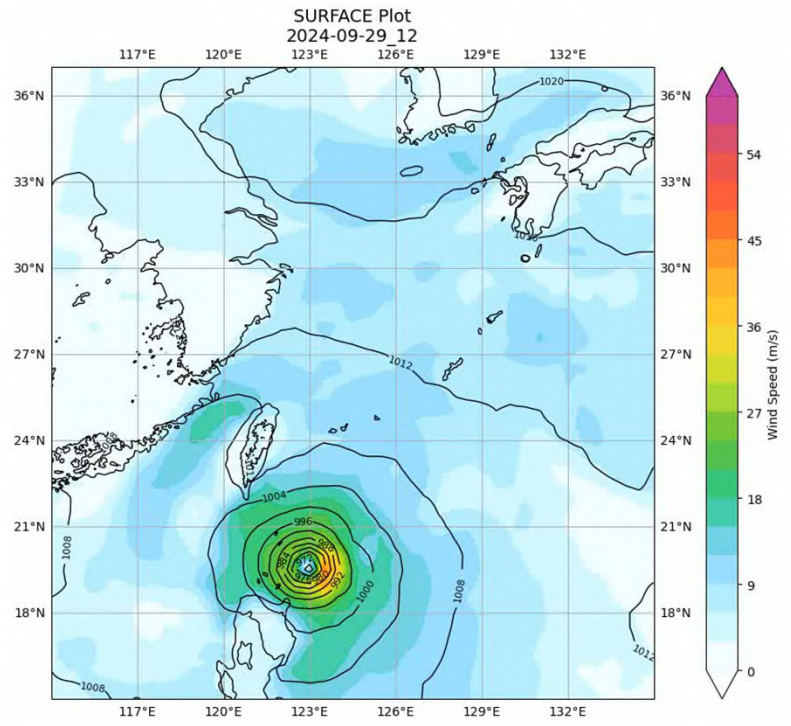
藍色：恆春半島以東登陸，或者是直接從台灣東方海面掠過(4 members)
綠色：從高雄一帶登陸(6 members)
橘色：CTL

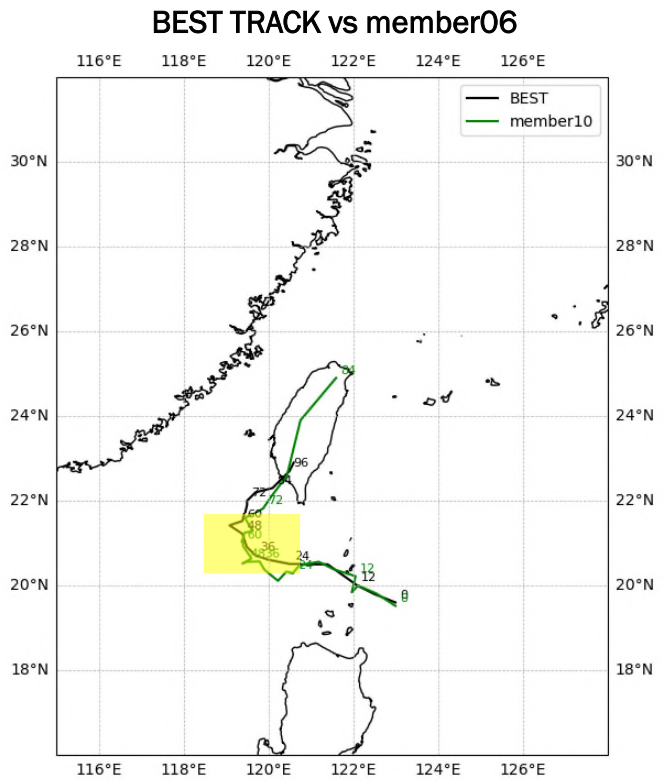


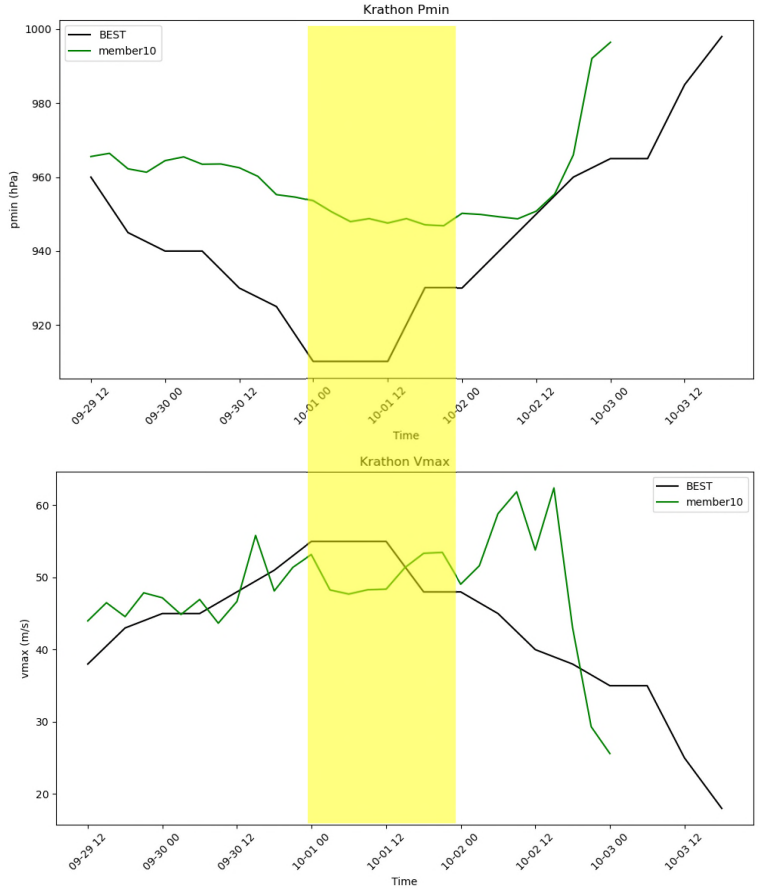
CWA accumulated rainfall
(Data source: Typhoon Database)



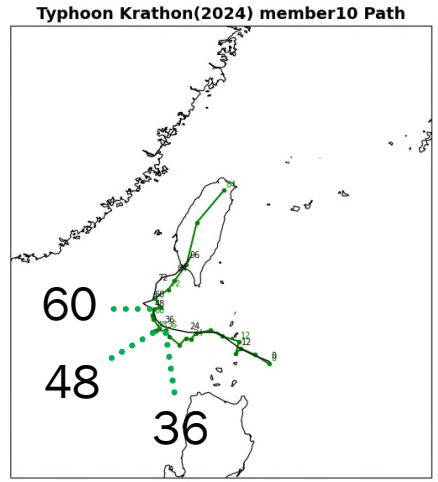
BEST SIMULATION: MEMBER10

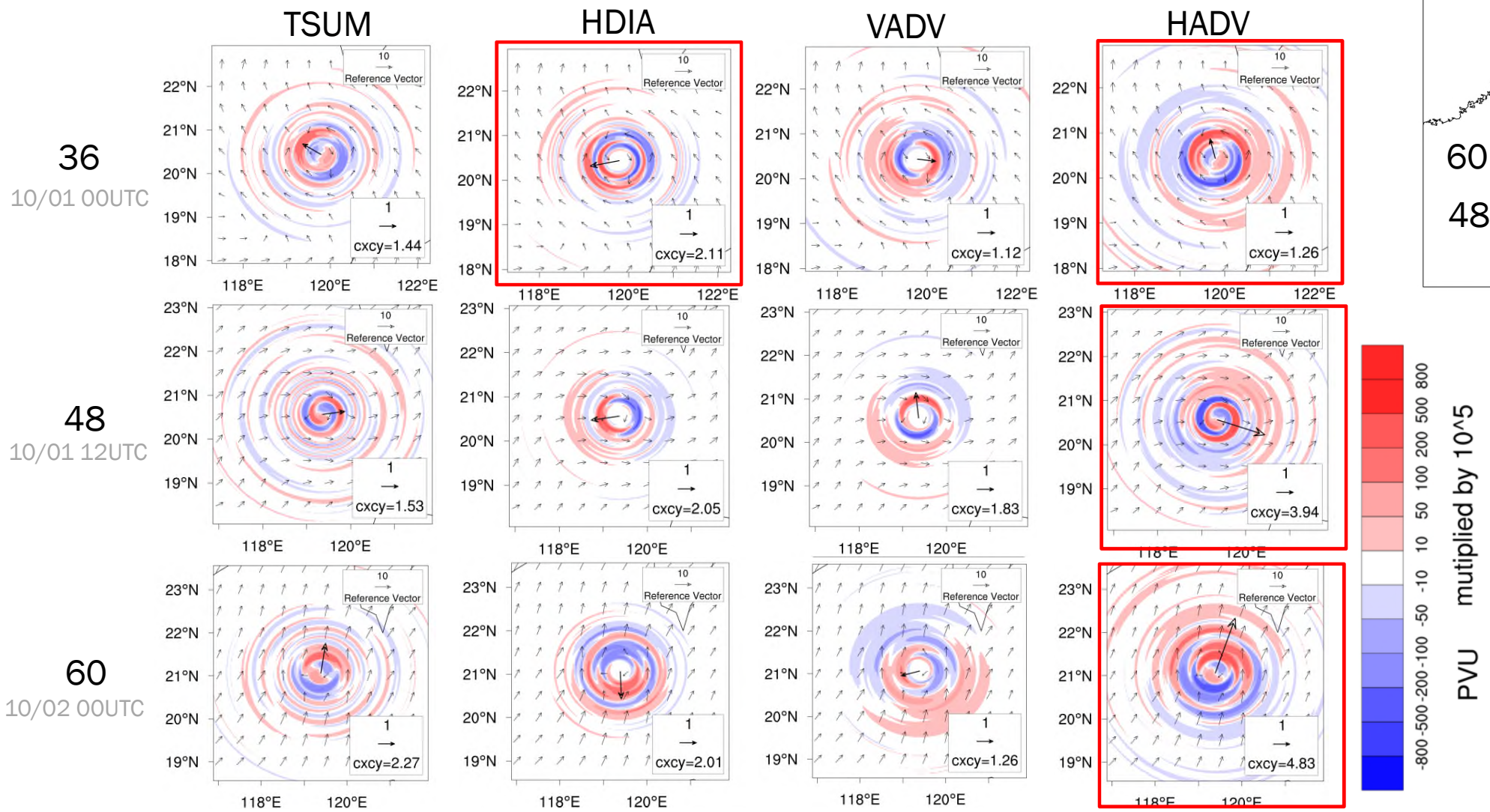






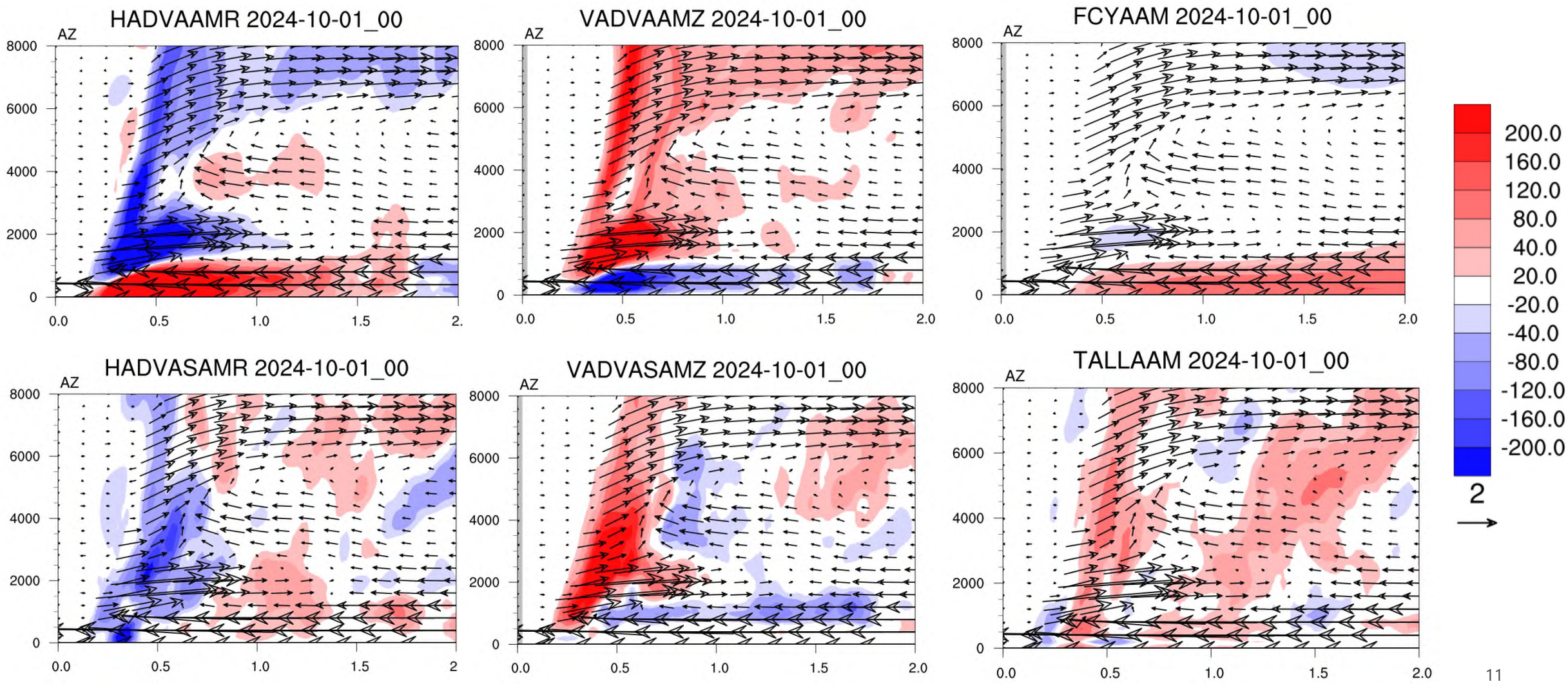
PV PUBGET WN1 – MEMBER 10



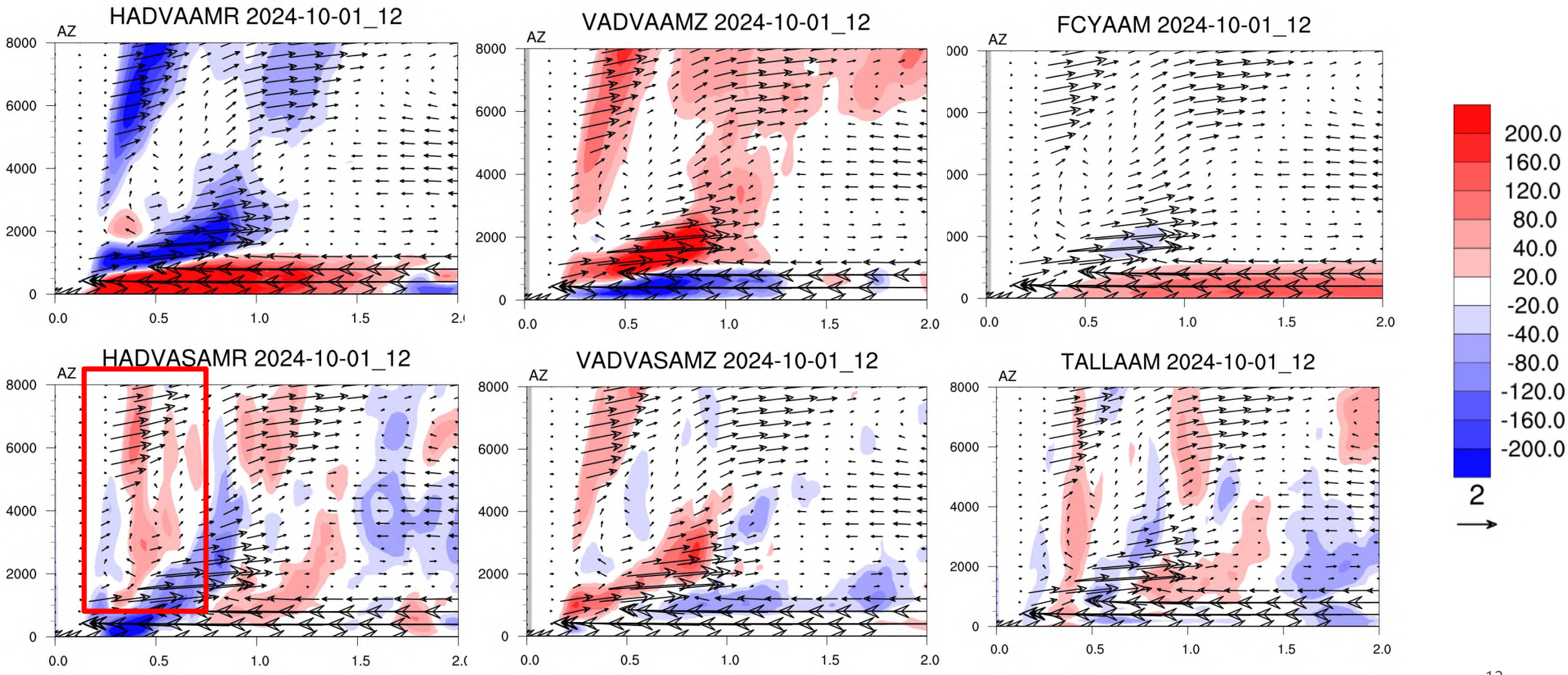


AAM– MAMBER 10 36HR(10/01 00UTC)

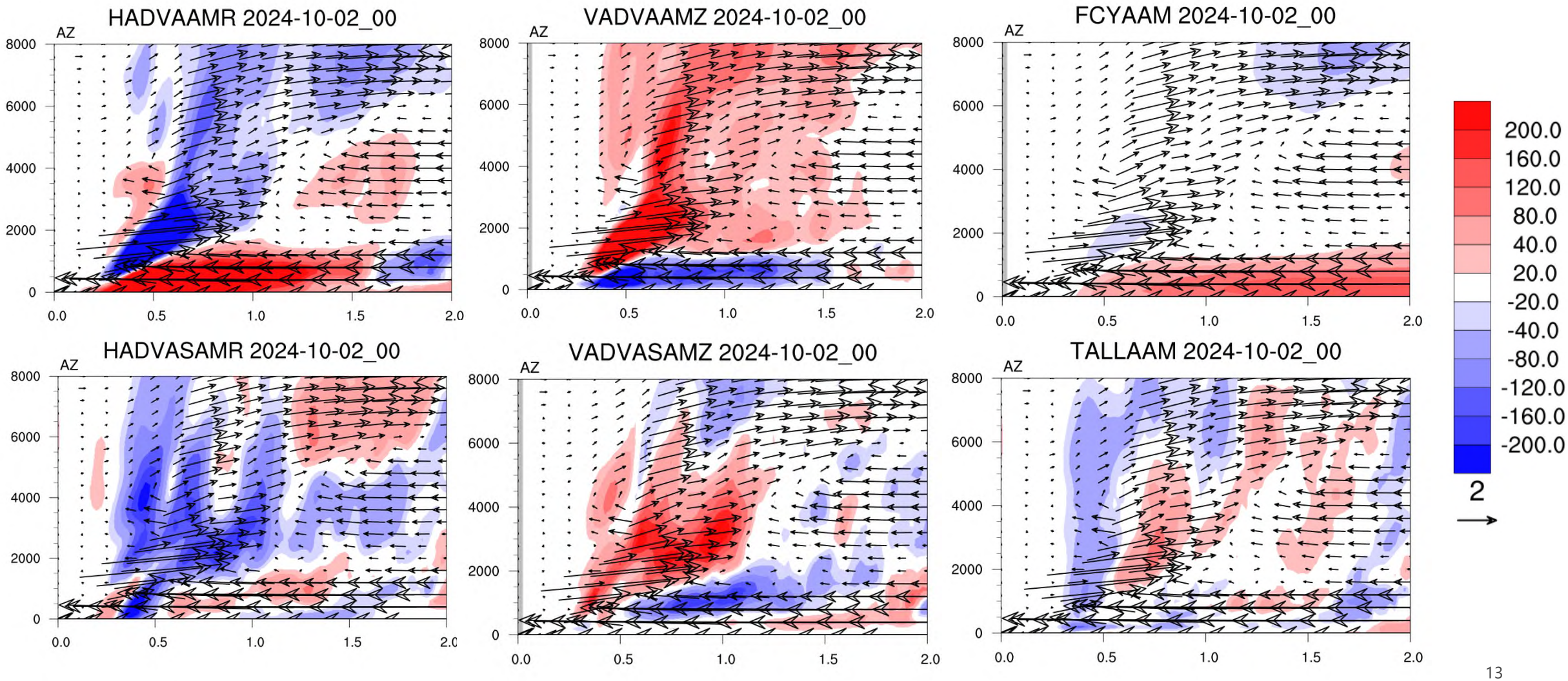
科氏力項



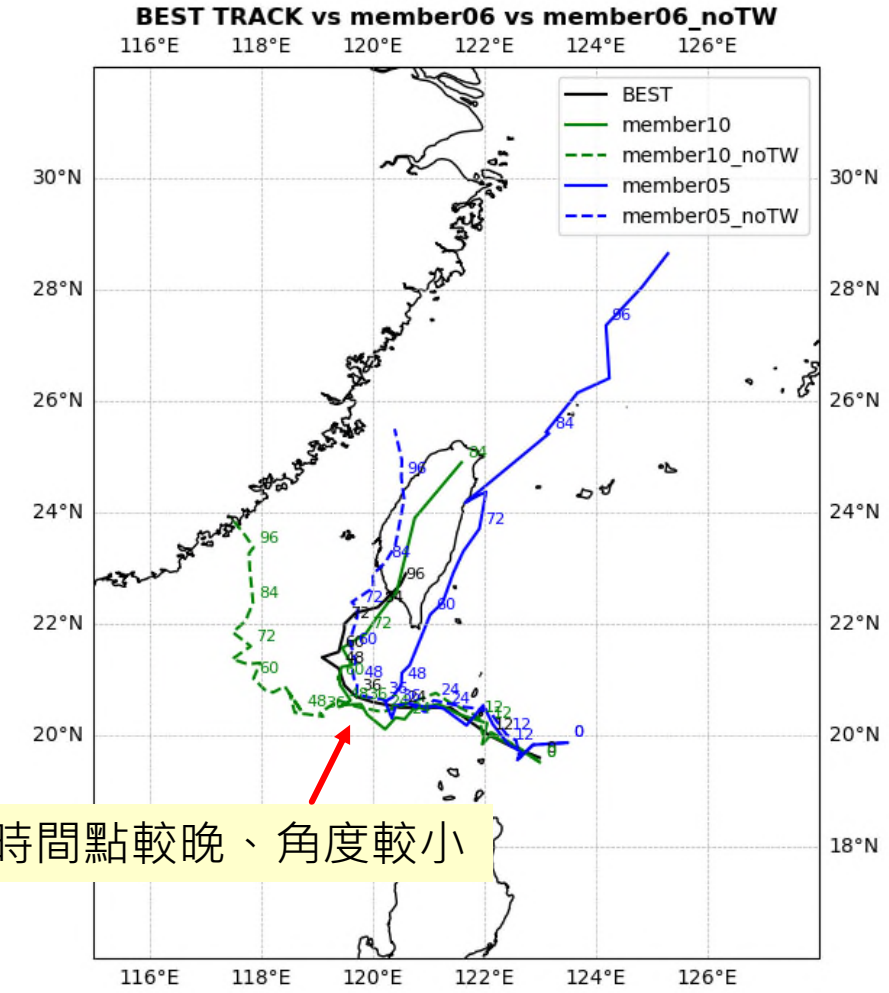
AAM– MAMBER 10 48HR(10/01 12UTC)



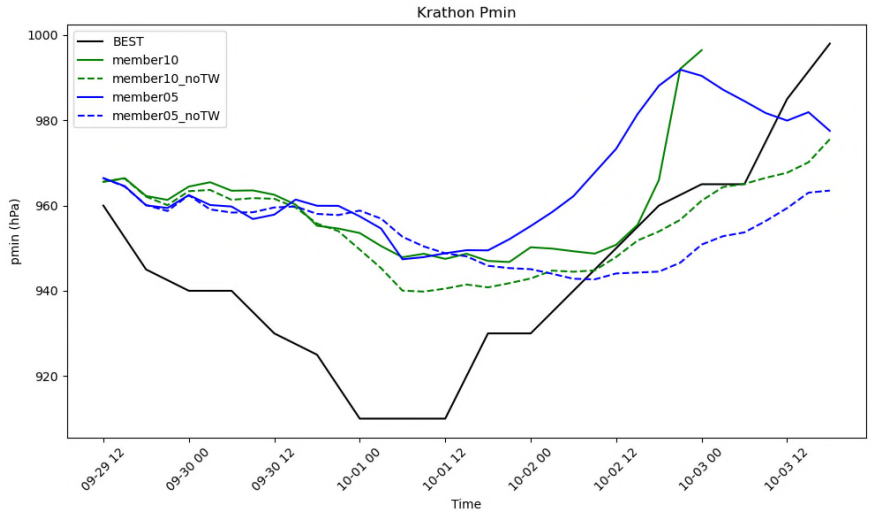
AAM– MAMBER 10 60HR(10/02 00UTC)

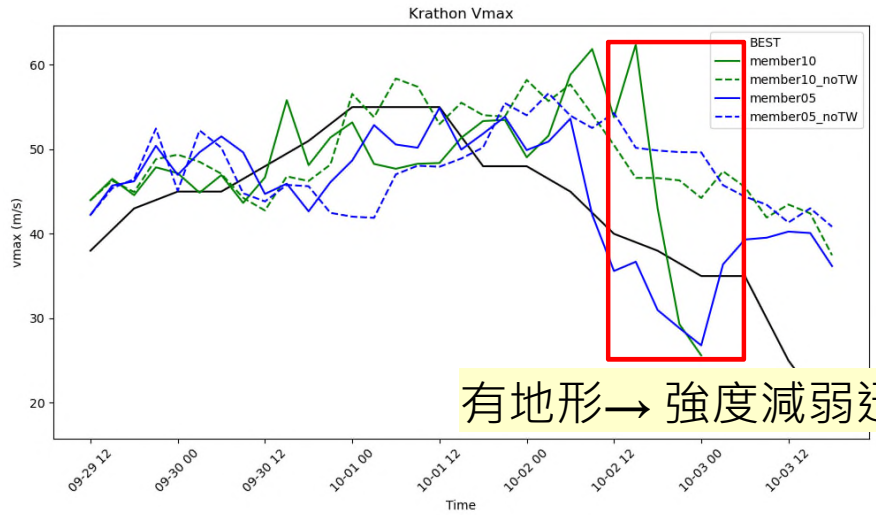


RESULTS – NO TERRAIN EXPERIMENT



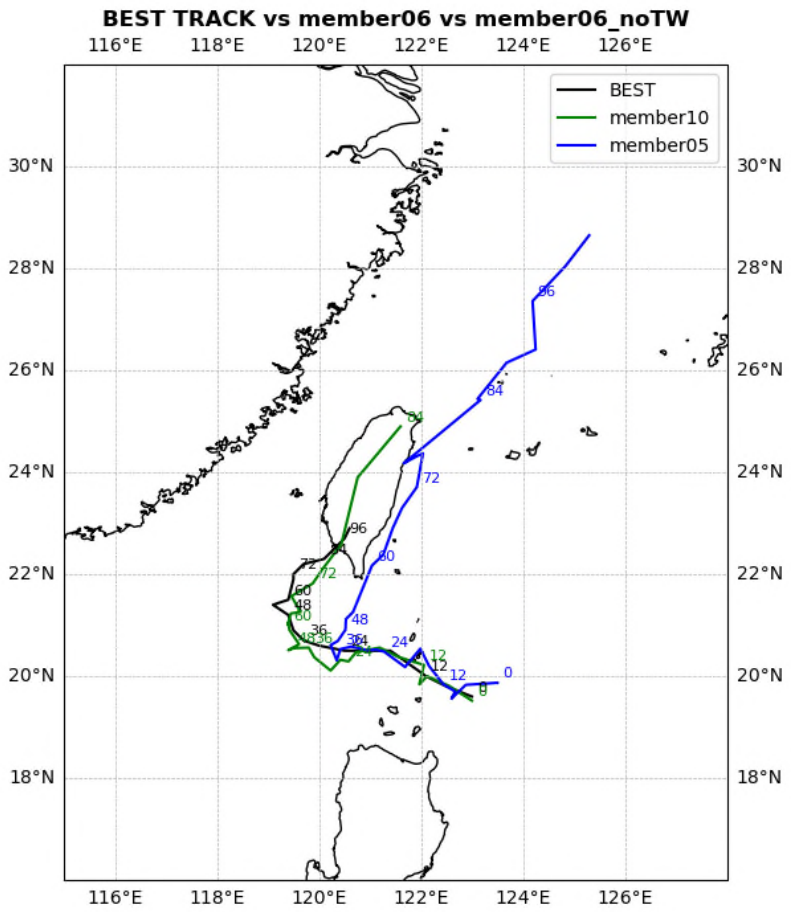
發生北轉的時間點較晚、角度較小

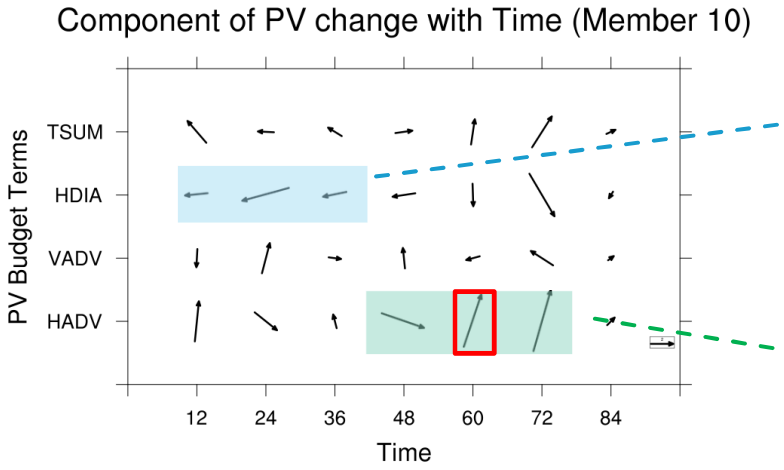




有地形→ 強度減弱迅速

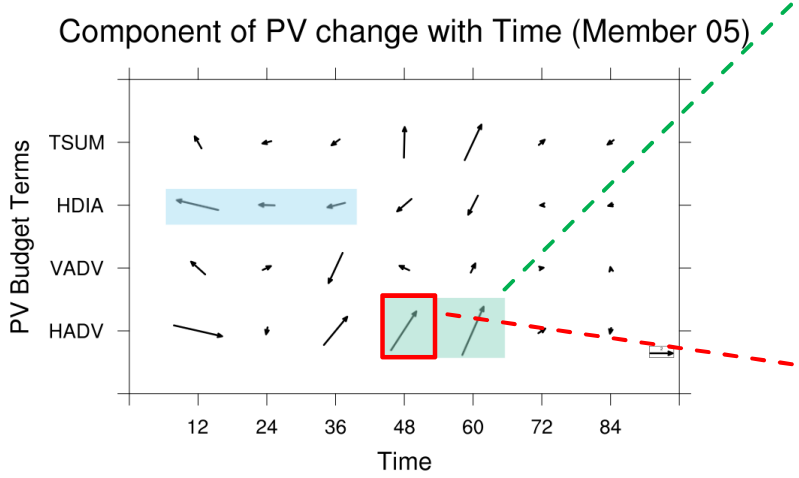
PV BUDGET TIME SERIES - WITH TERRAIN





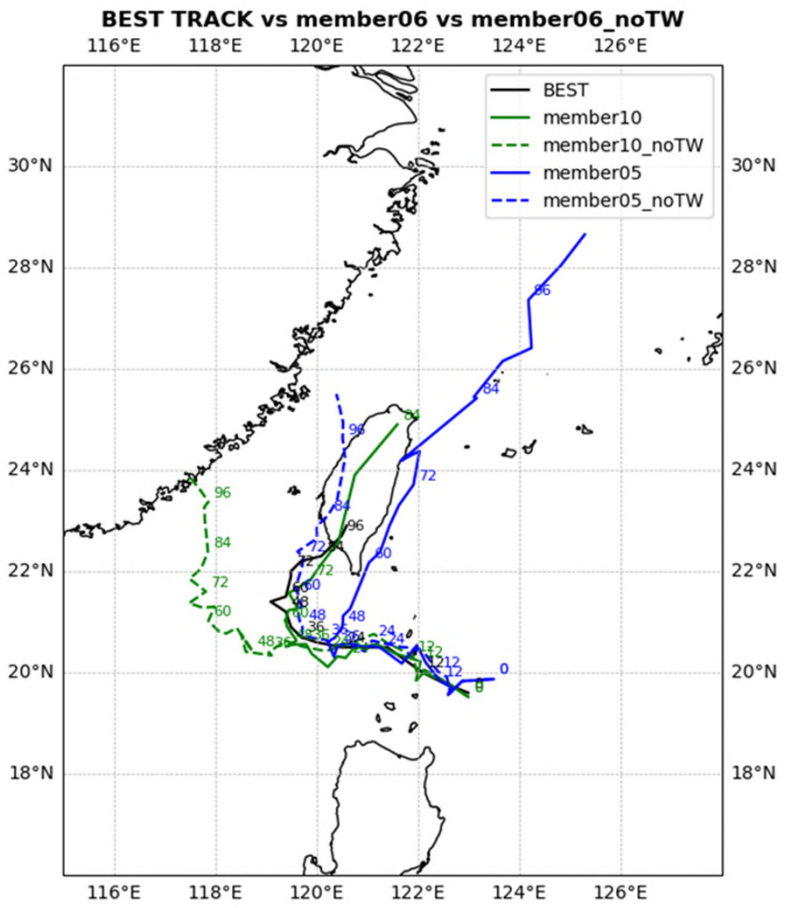
北轉前(12~36hr)，西向分量主要由 **HDIA** 主導

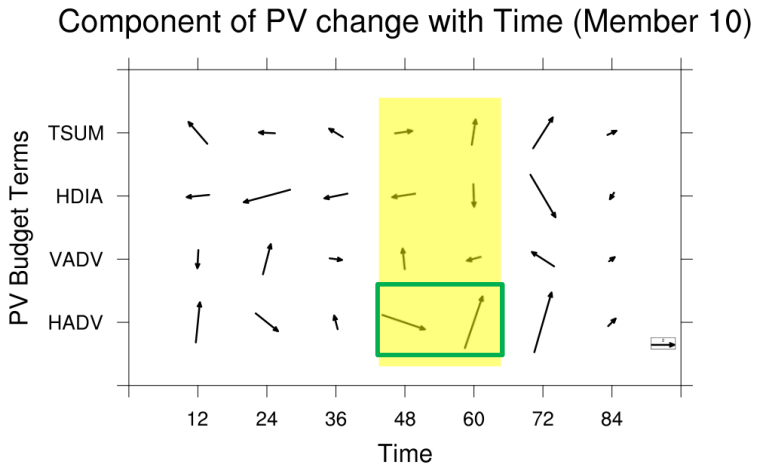
北轉後(after 48hr)，北向分量則主要由 **HADV** 主導

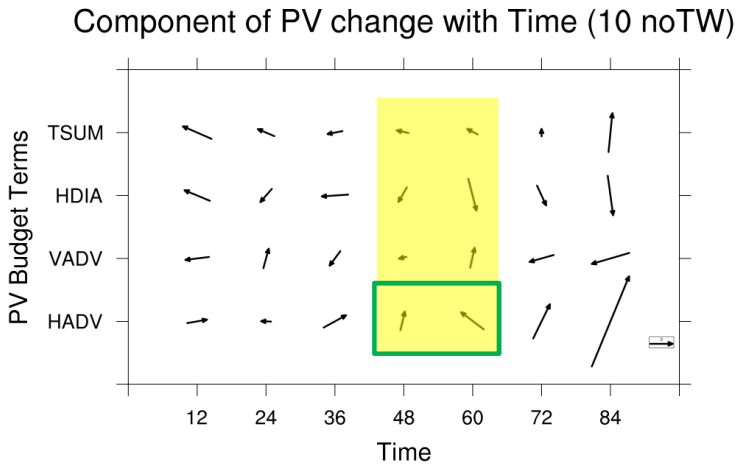


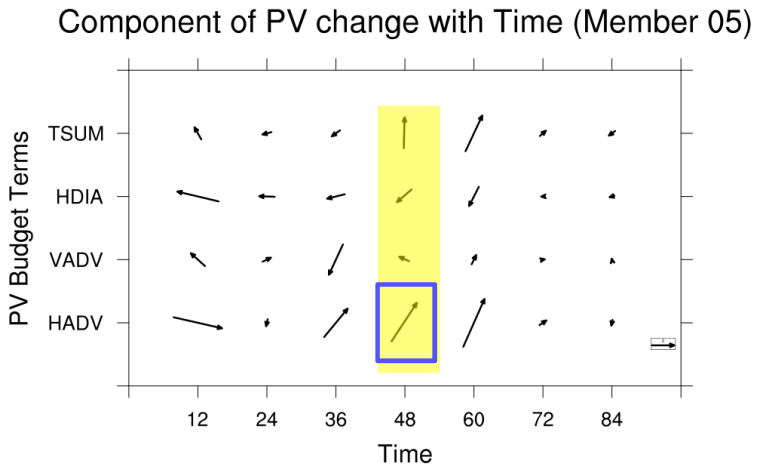
member5 的水平平流項導致的北向分量比 member10 **更早出現**

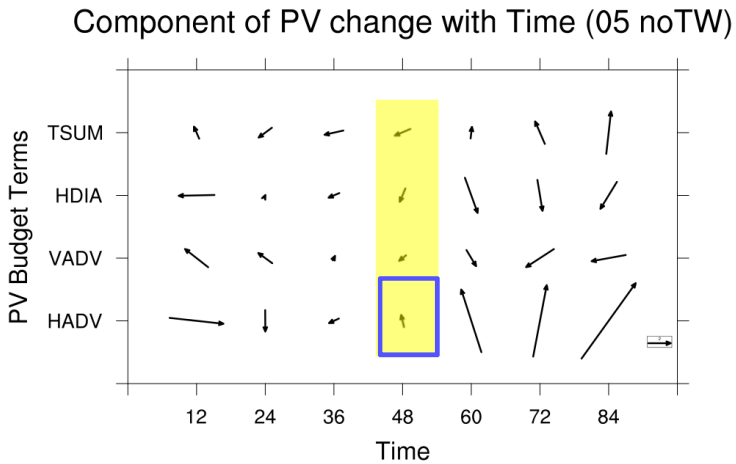
PV BUDGET TIME SERIES – NO_TW







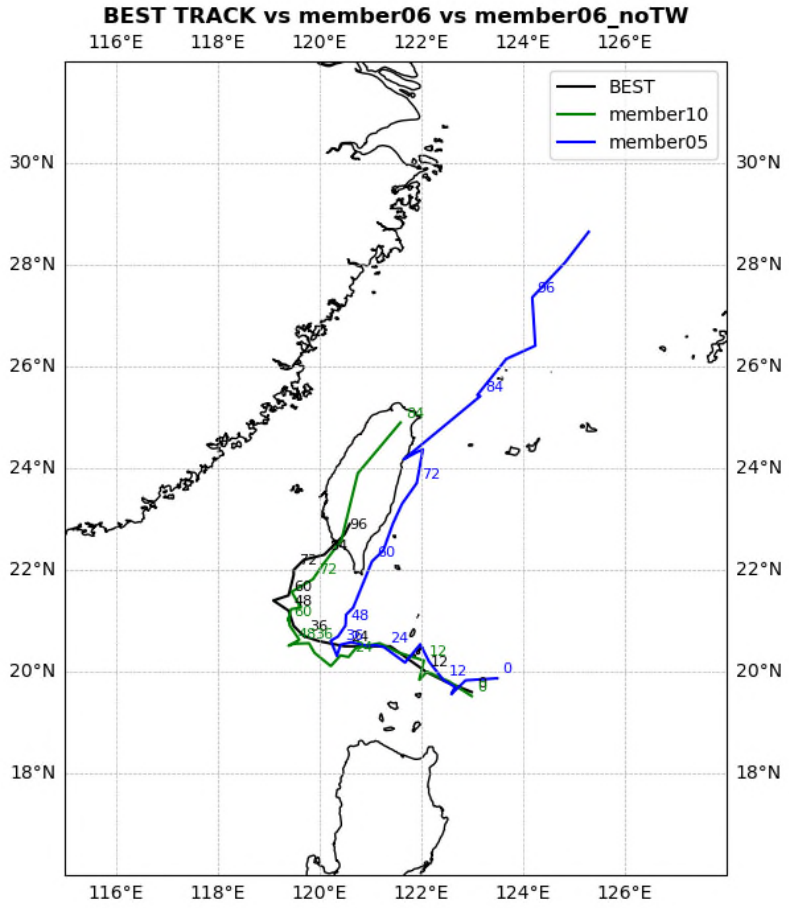




Turning point (in track)

有地形 → 強 HADV

無地形 → 弱 HADV



Discuss stagnation in terms of 850-hPa large-scale circulation

Member10 vs. Member5 vs. Reanalysis

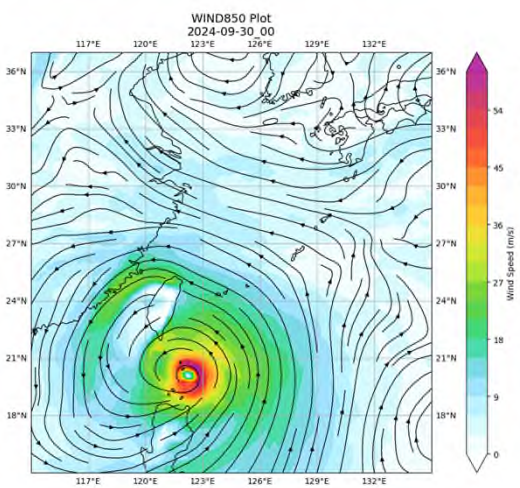
Before stagnation

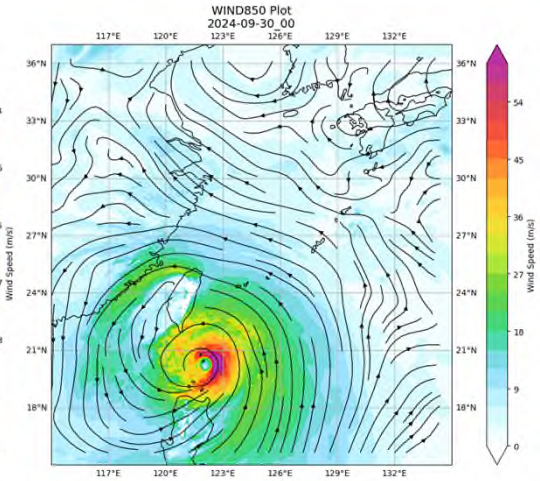
NCEP Reanalysis

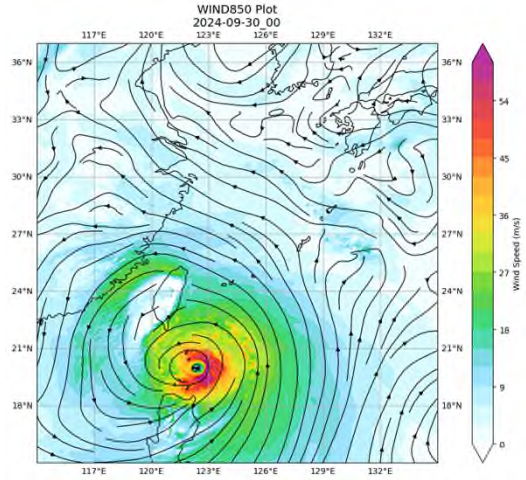
Member10
Westward

Member5
Eastward

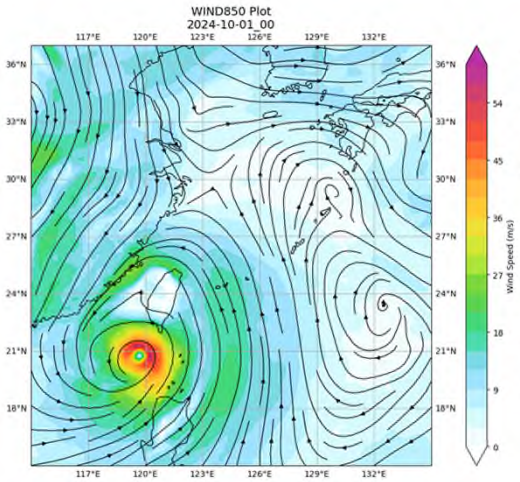
09/30
00UTC

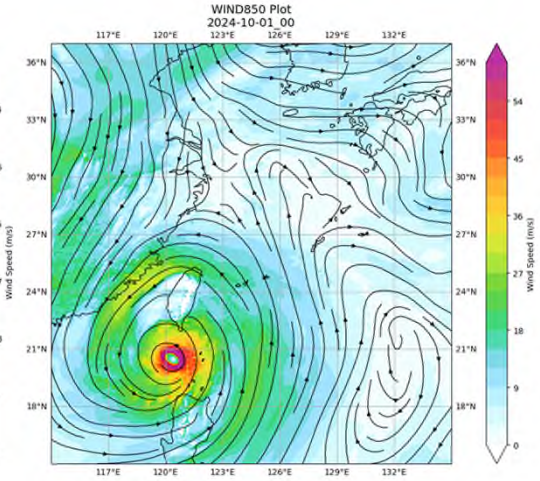


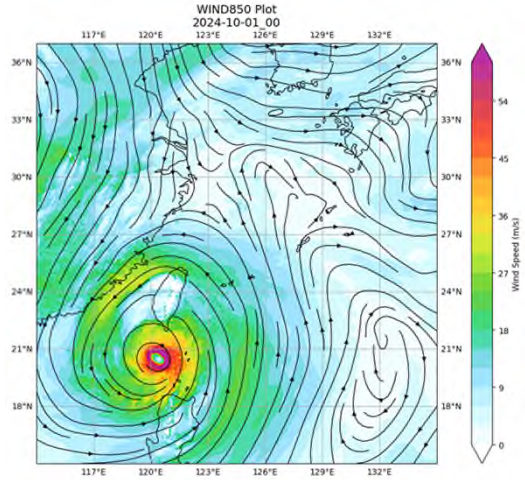




10/01
00UTC







- 9/30 颱風穩定向西移動，主要受到太平洋副高所影響
- 10/1 大陸冷高壓南下

再分析場與兩個模擬成員之間並沒有太大差異

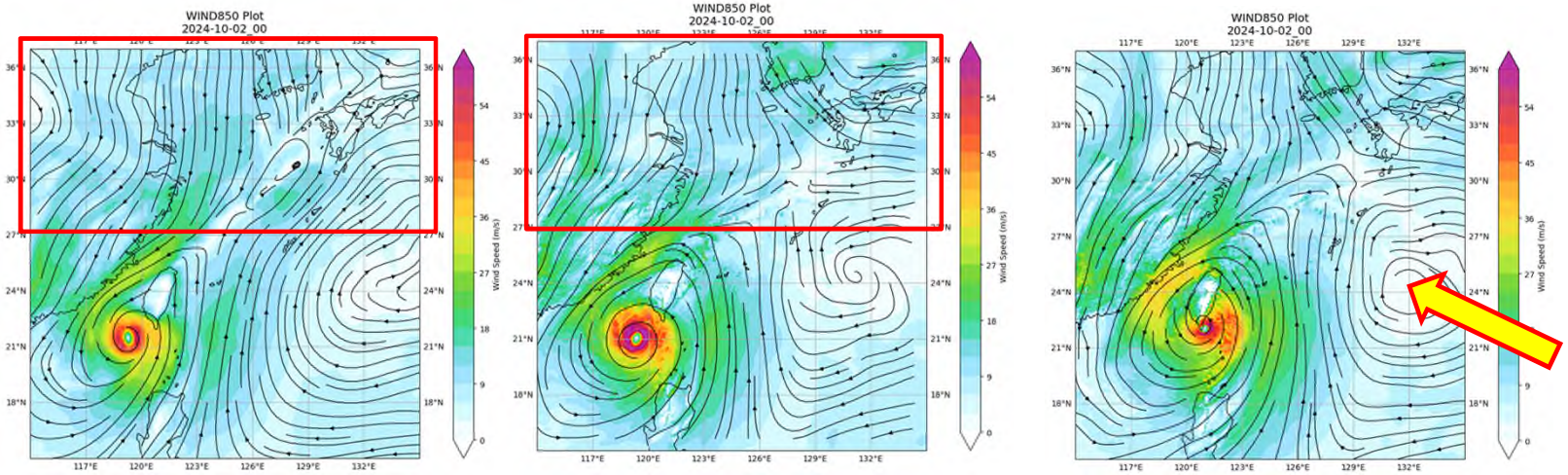
During stagnation

NCEP Reanalysis

Member10
Westward

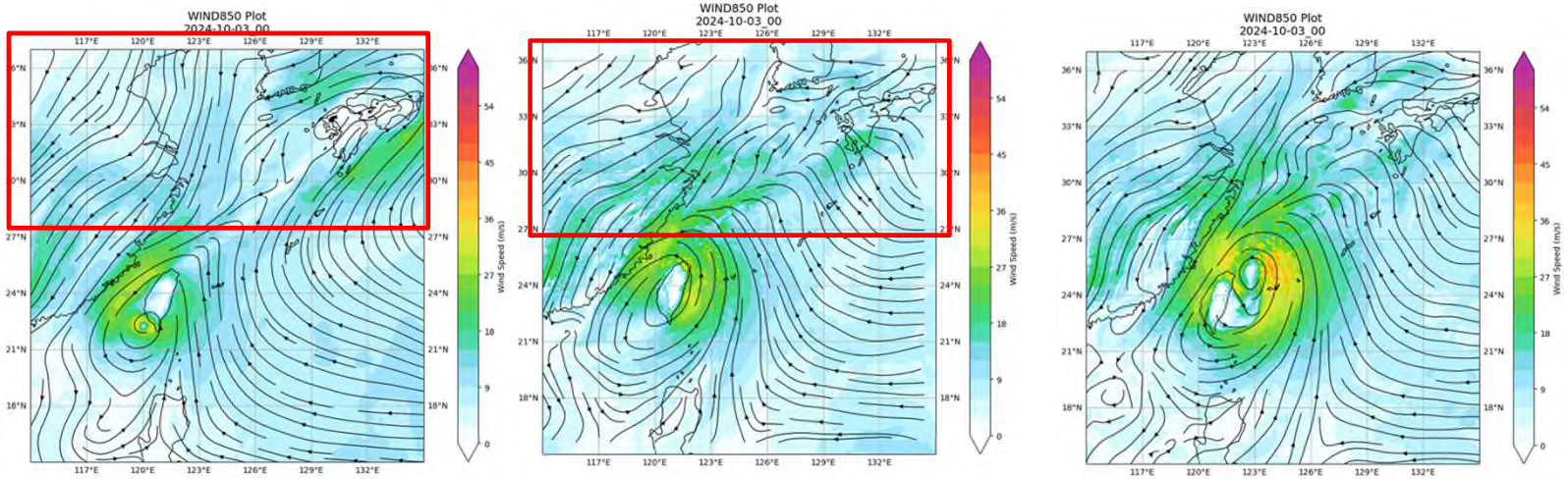
Member5
Eastward

10/02
00UTC



太平洋高壓東退，強風軸東移

10/03
00UTC



10/2後，太平洋副高的位置明顯與再分析場不符

區域模式邊界條件設置

CONCLUSION

- **位渦收支分析**：

  颱風轉彎前(12-36hr)：颱風的移動主要由非絕熱加熱所主導。

  颱風轉彎後(48hr後)：主導項轉為水平平流，且地形對水平平流項影響很大。

- **角動量收支分析**：

  受到低層水平外流的影響，可看出颱風在滯留期間結構減弱並且消散

- 透過移除地形的實驗，可證實地形對颱風強度和北轉幅度的影響
- 在模擬進行至第 60 小時後，模式雖能掌握冷高壓的發展趨勢並成功模擬其消散，但在北側太平洋副高的環流表現上仍存在顯著誤差

FUTURE WORK

- 對最佳模擬結果 (member10) 進行物理參數方案調整，並探討與降雨結果的關聯性
- 將系集擾動組數提高至 30-60組，並評估預報的準確度與敏感度
- 針對最佳結果進行全球模式的實驗，觀察是否能降低副高的預報誤差

THANKS FOR LISTENING