Recenter風場應用於波浪系集預報模式之研究

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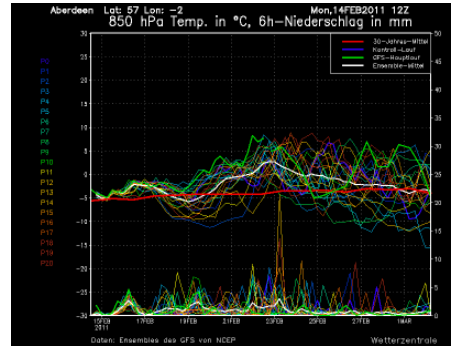
簡報大綱

- 系集預報
- 相關研究
- 颱風案例
- 結論

系集預報



- 二個或以上的預報集合。
- 源自於數值天氣預報領域，以已知觀測建立起點，推算未來天氣的演變，但由於觀測資料的不足，無法真正得知當下實際的天氣是如何。
- 為了克服初始微小誤差對數值天氣預報的影響，氣象學家發展出系集的概念。
- 估算初始誤差對天氣預報準確度的影響，進而從這些預報的統計平均值(例如算術平均)取代單一的預報。
- 藉由整合許多數值預測來預測氣象或氣候事件發生的可能性，期望整合後能包含模式預報的不確定性，並且將不確定性量化，以提供未來的機率預報。

統計指標

決定性預報	系集預報	
統計指標	屬性(attributes)	統計指標(measures)
相關係數(correlation)	準確度(accuracy)	Brier Score (BS), Brier Skill Score(BSS)
偏差(BIAS)	信賴度(Reliability)、解析度(Resolution)、銳度(Sharpness)	Reliability Diagram
均方根誤差(RMSE)	區別事件發生能力(Discrimination)	Relative Operating Characteristic(ROC)
散度(SI, scatter index)	離散度評估(定性) (outliers, biases)	Talagrand Rank Histograms
Ps(Performance score)	**離散度評估(定量)及不確定性**	**RMSE & SPRD**
	系集成員組成	Member Equal Likelihood

相關研究

NOAA：The Global Ensemble Ocean Wave Forecast System (GEOWaFS)
FNMOC：

- 40個member
- 240 小時

NCEP/FNMOC Wave Ensemble Product Viewer

The content provided on this page supports model development. These are not official NWS products and should not be relied upon for operational purposes. This web site is not subject to 24/7 support, and thus may be unavailable during system outages.

Operationally generated graphics of the wave fields (no spectra or source terms) are available from Model Analyses and Guidance.

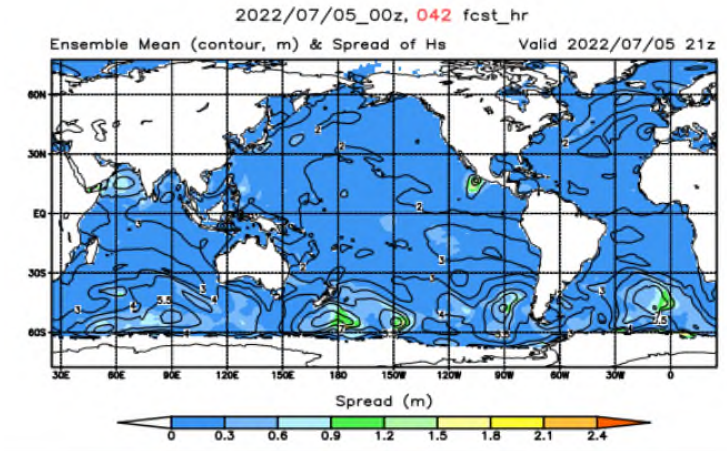
Bulletin files are available from the Production FTP/HTTPS server. Look for gfs.YYYYMMDD/CC/wave/station/bulls.tCCz/gfswave.stationID.bull

Choose a Model | 2022/07/05 00z | Mean & Spread

Significant Wave Height | Wind Speed | Peak Wave Period

Mean & Spread Plot - 2022/07/05 00z
Significant Wave Height forecast for 42 Hours

Loop Images: << Stop >> | Adjust Speed: Slower Faster | Advance One: |< < > >|

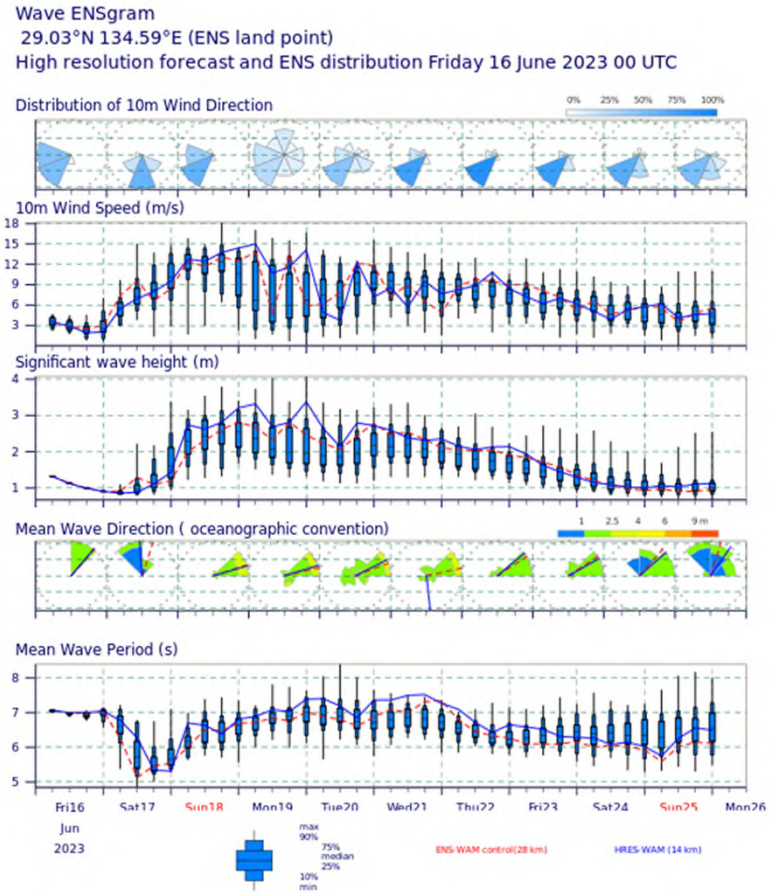


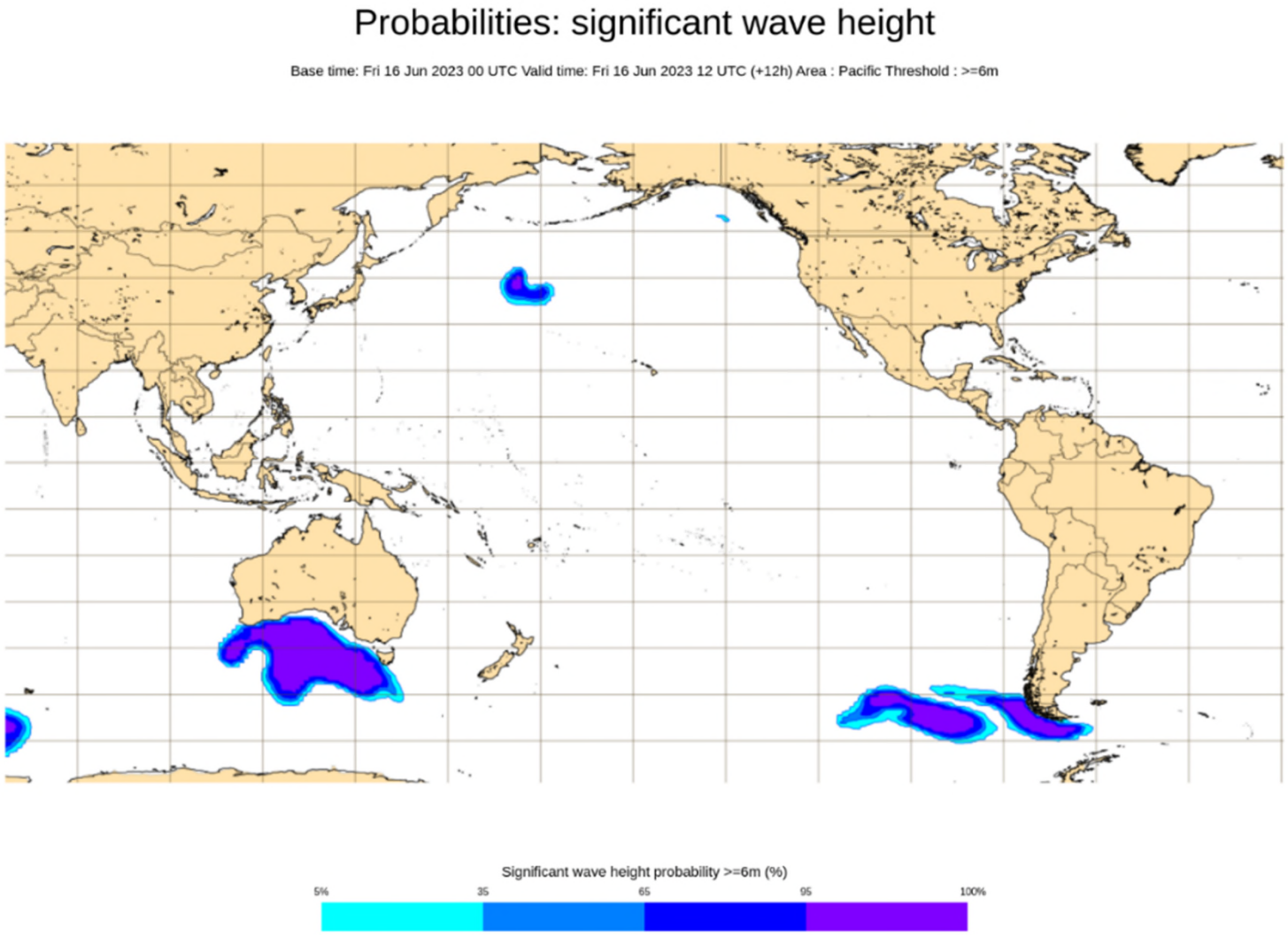
Chen(2006)&Cao(2007)

- 系集分岐隨時間增加
- 比決定性預報更符合實際且更合理，亦是較佳的預報及決策工具

ECMWF： Wave Ensemble Prediction System meteogram (Wave EPSgram)

- 50組初始平均擾動生成風場和1個作業化波浪起始場(ECWAM)
- 產生其他50個members
- 10m風速、10m風向、示性波高、平均波向與週期等
- 盒鬚圖
- 示性波高、平均週期等之機率圖，其中包括每12小時的預報共360小時及未來10-15天的平均預報，而機率圖的分檻值包括波高2m、4m、6m、8m等，平均週期8s、10s、12s、15s等，模式範圍包括全球、太平洋共30個區域，
- 0.5°x0.5°(全球)

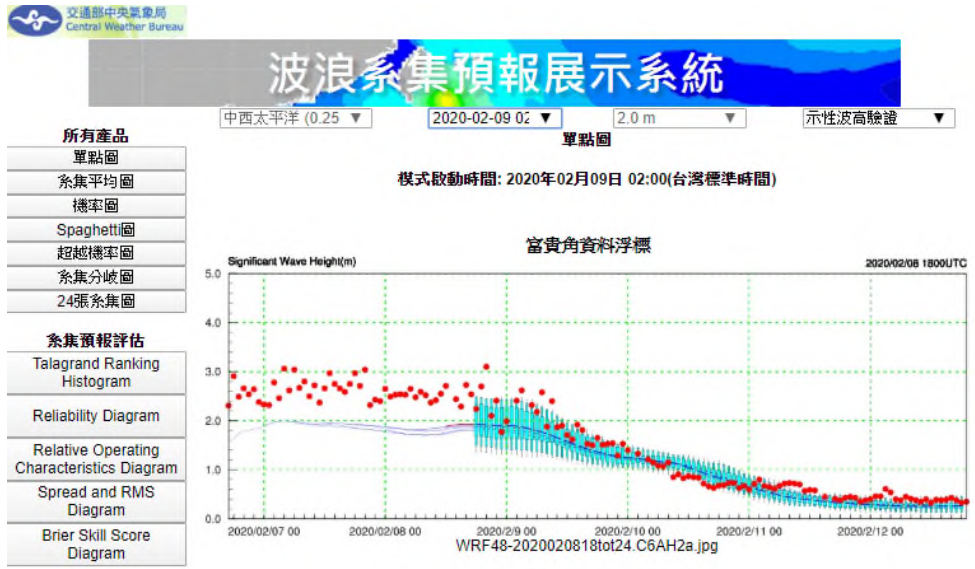


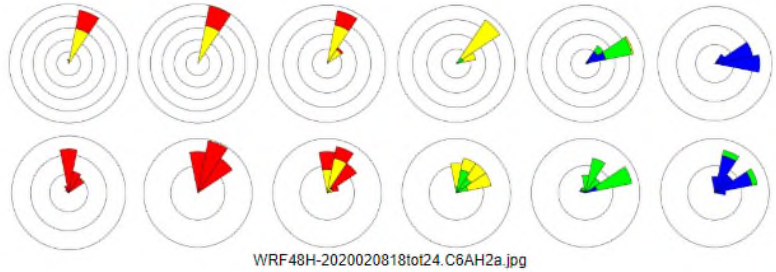


ECMWF示性波高機率產品(Hs>6m)

CWA： Wave Ensemble Prediction System

- WEPS 2.0 系集風場
- 24個members (WW3 3.14)
- 96小時
- 10m風速、10m風向、示性波高、平均波向與週期等
- 盒鬚圖
- ST2、ST3
- 0.25°、0.1°、0.025° (西北太平洋)

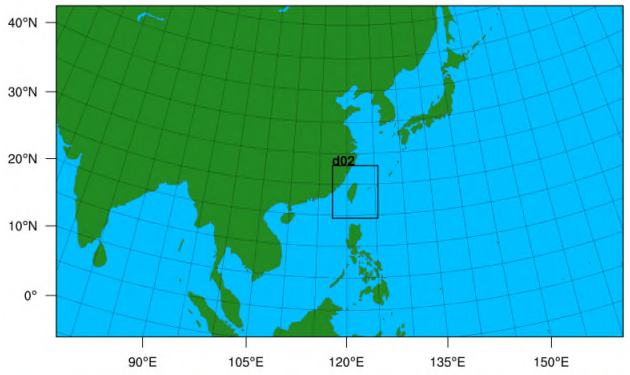




recenter風場

WEPS 2.0

15km、3km



模式產出

Ensemble mean & spread

預報中心

10km、2.5km

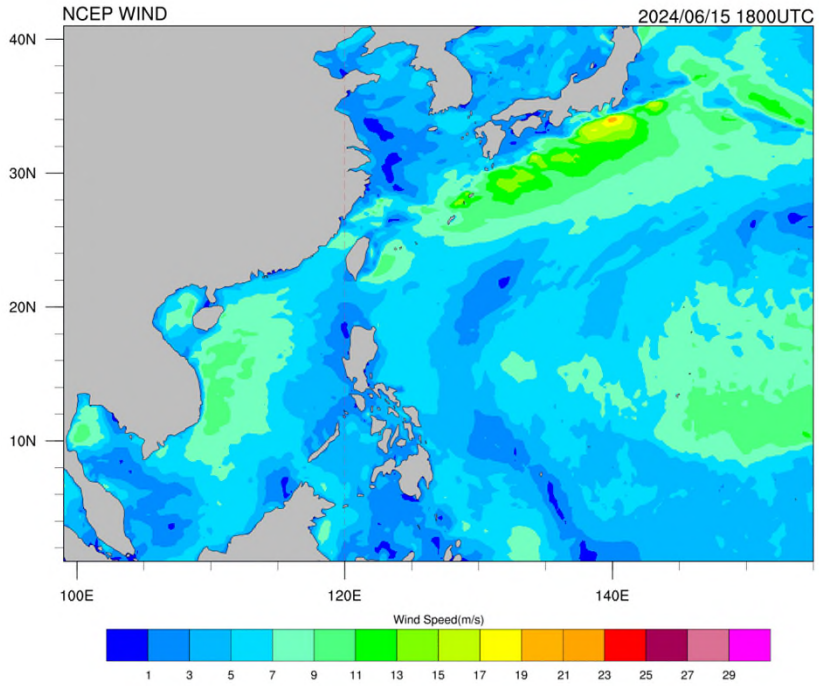
NCEP

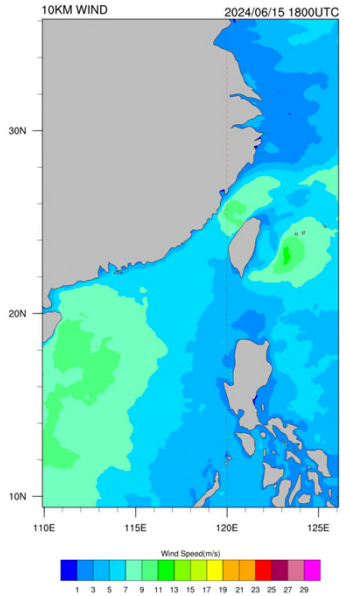
25km

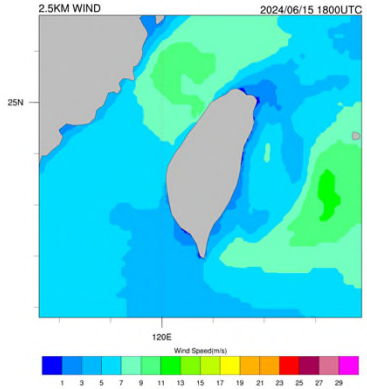
模式+人工調整產出

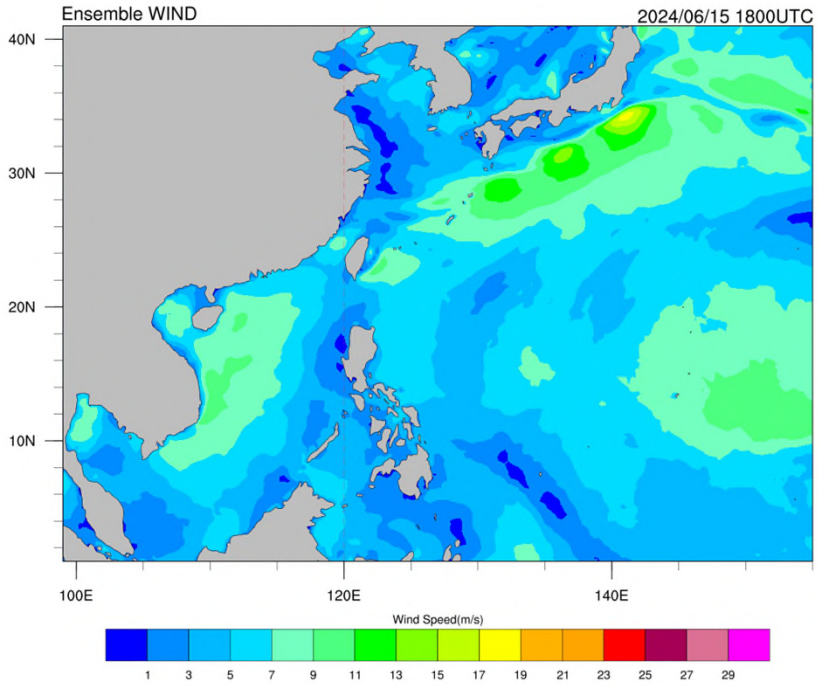
WW3 3.14 → WW3 6.07

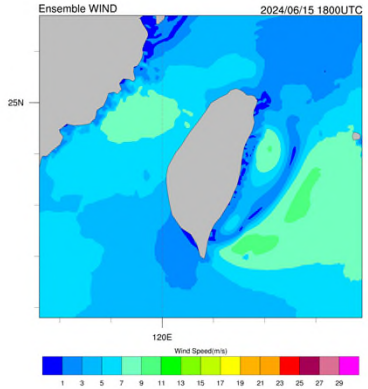
決定性預報三層風場與系集平均三層風場的比較

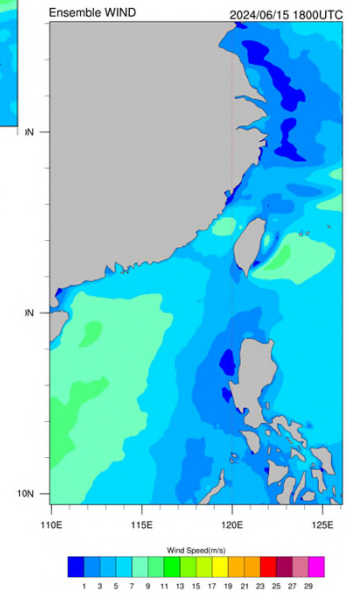






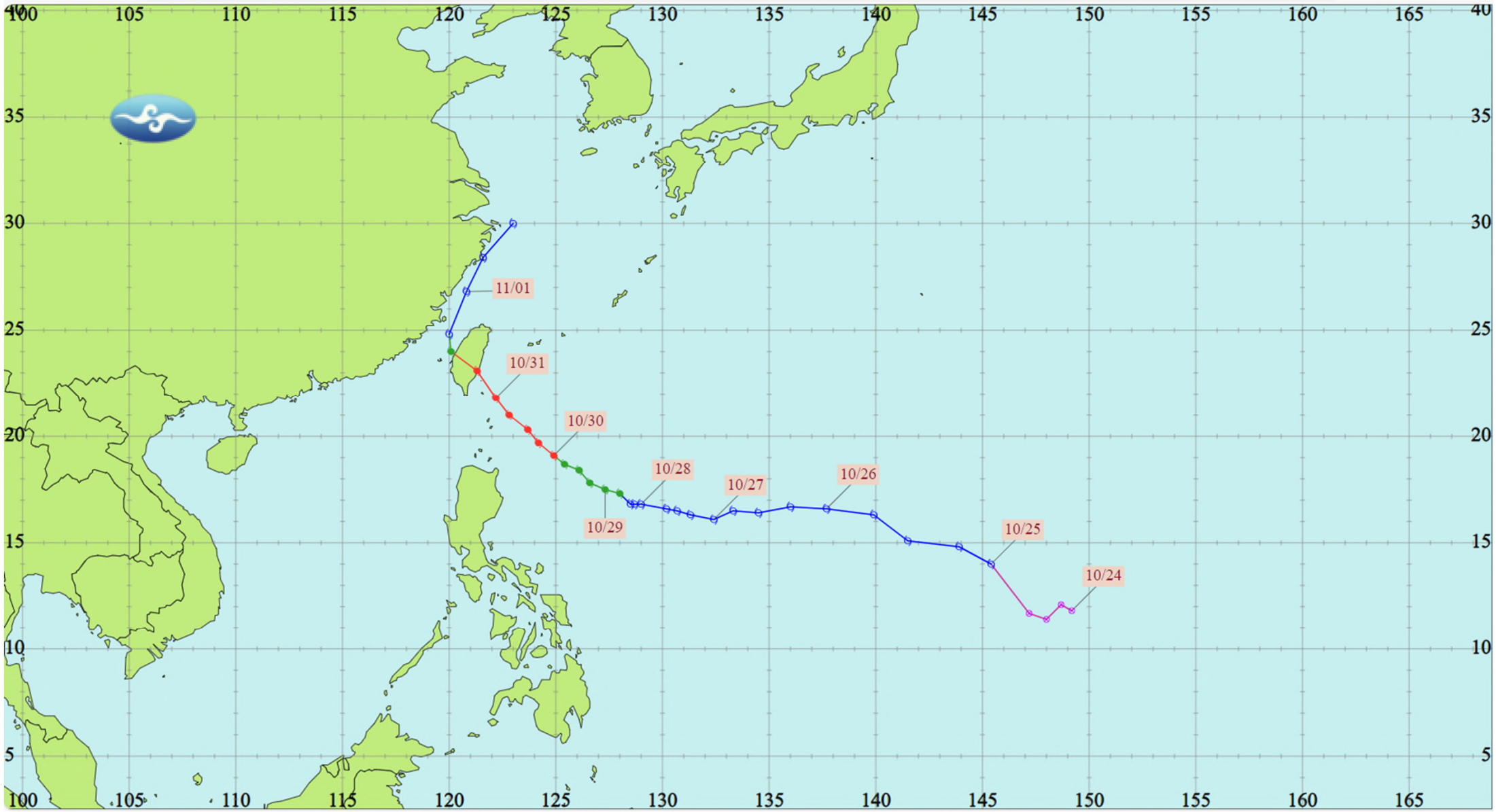






- 二者的分布型態均十分類似，決定性預報使用的風場較系集平均風場均有偏大的趨勢。

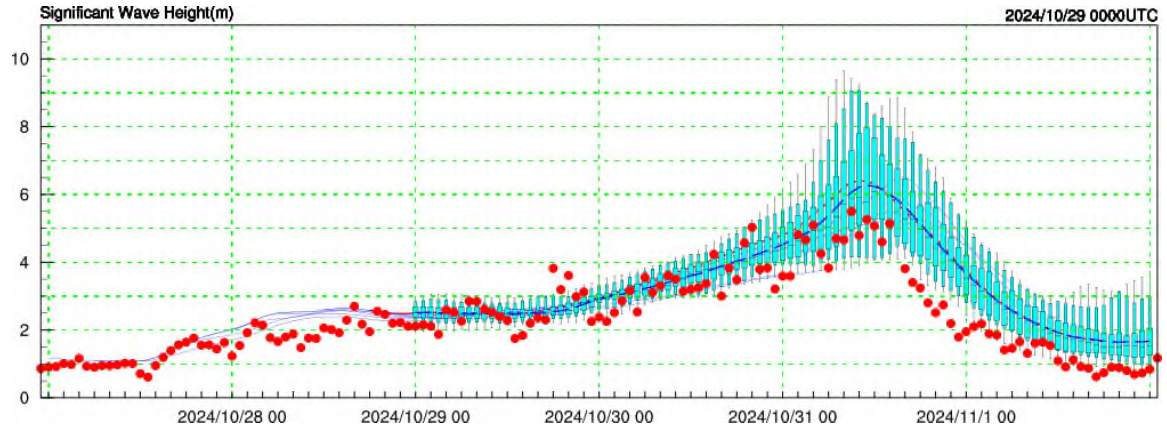
202421 康芮(KONG-REY)

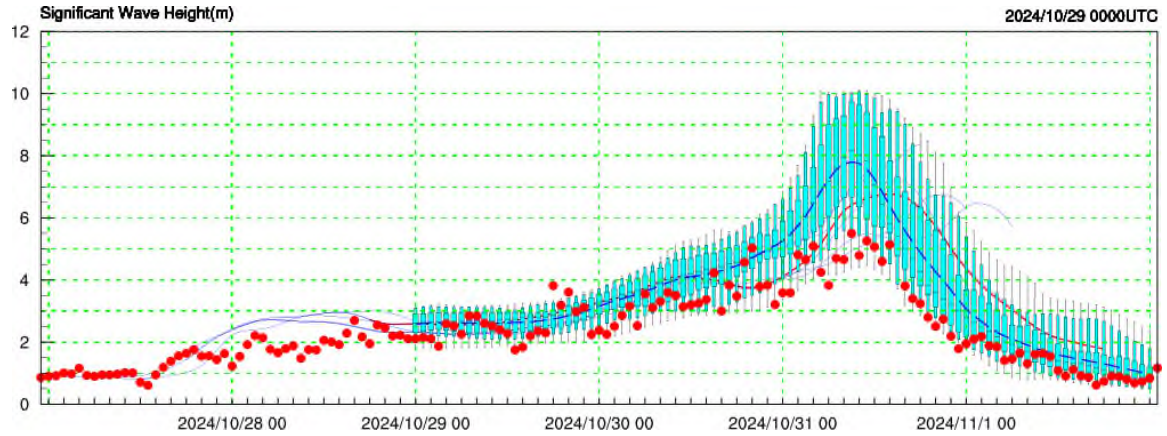


強烈颱風(Vmax>=51.0m/s) 中度颱風(Vmax32.7-50.9m/s) 輕度颱風(Vmax17.2-32.6m/s) ⊗熱帶性低氣壓(Vmax<17.2m/s)

康芮(KONG-REY)颱風

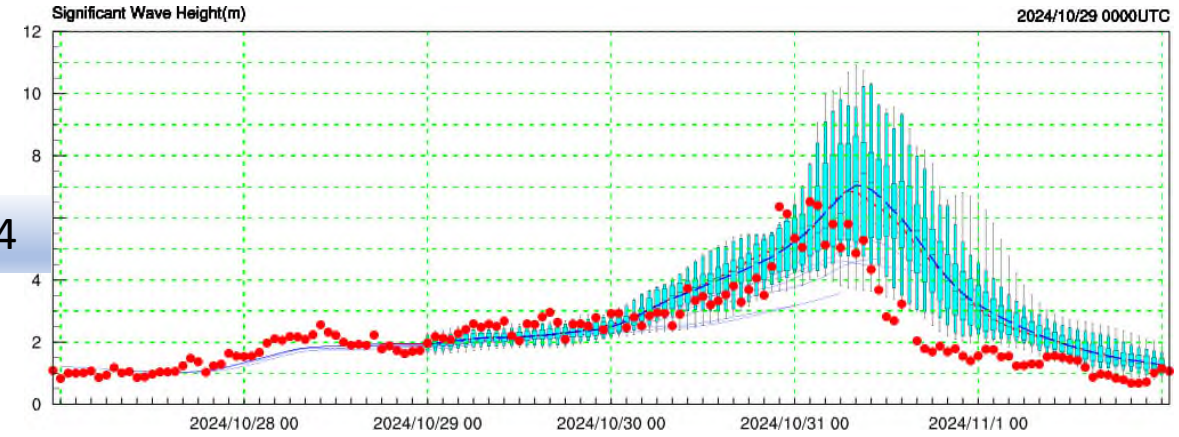
龍洞測站(46694A)



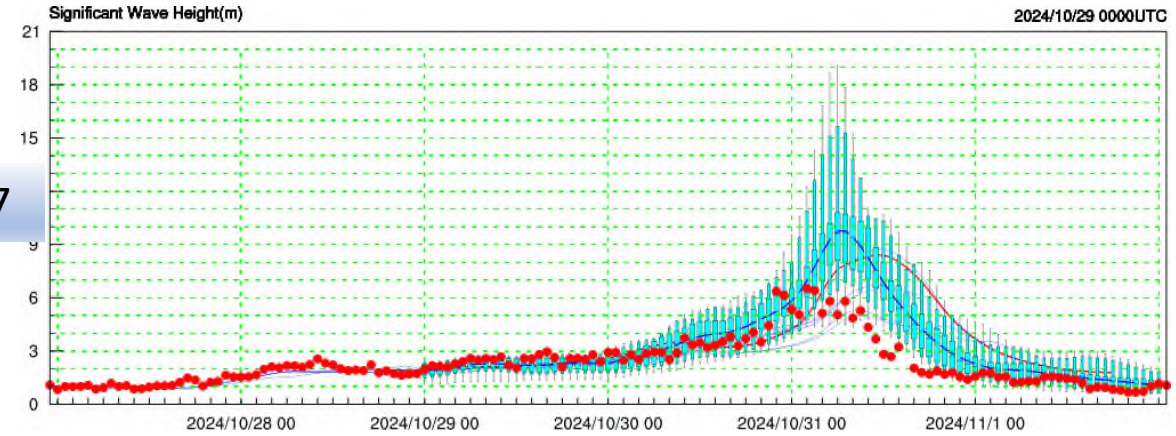


花蓮測站(46699A)

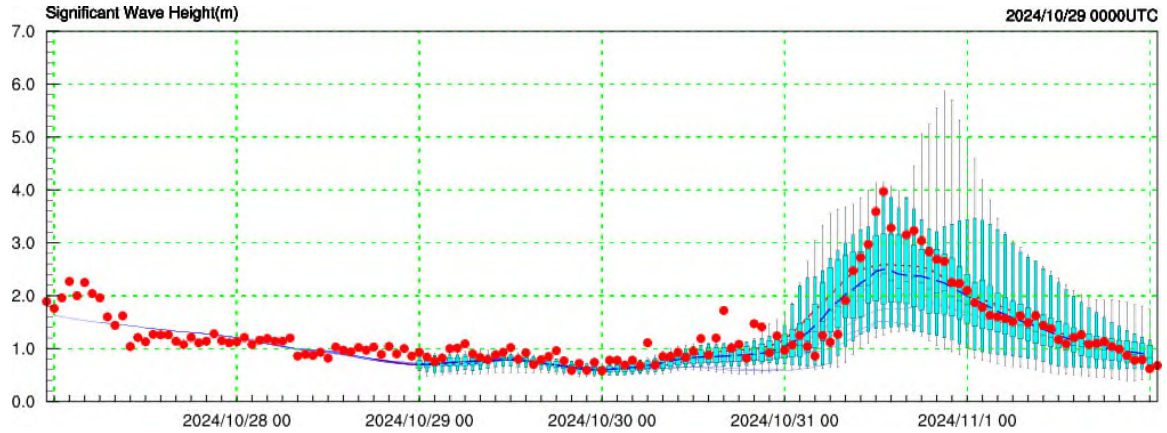
3.14

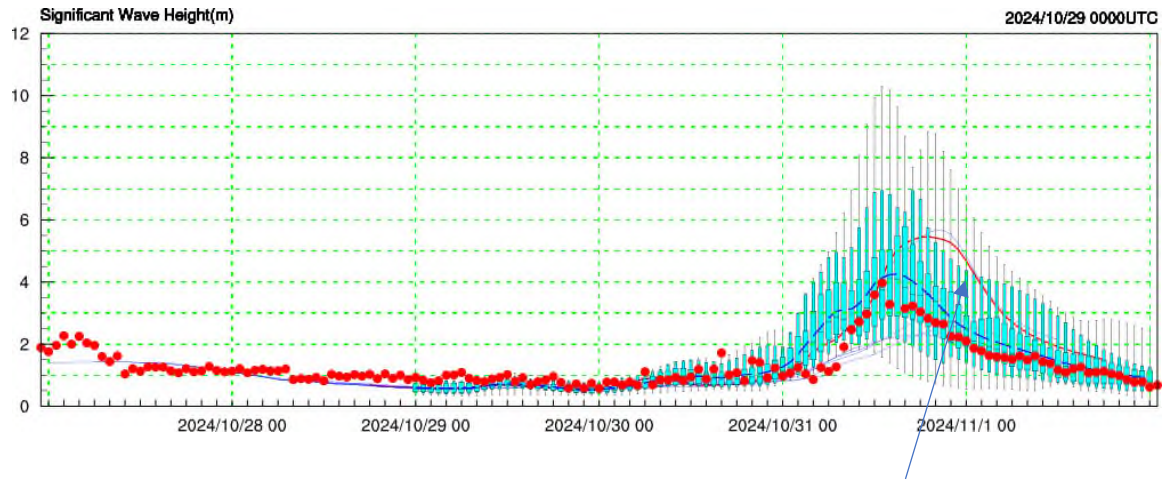


6.07



小琉球測站(46714D)

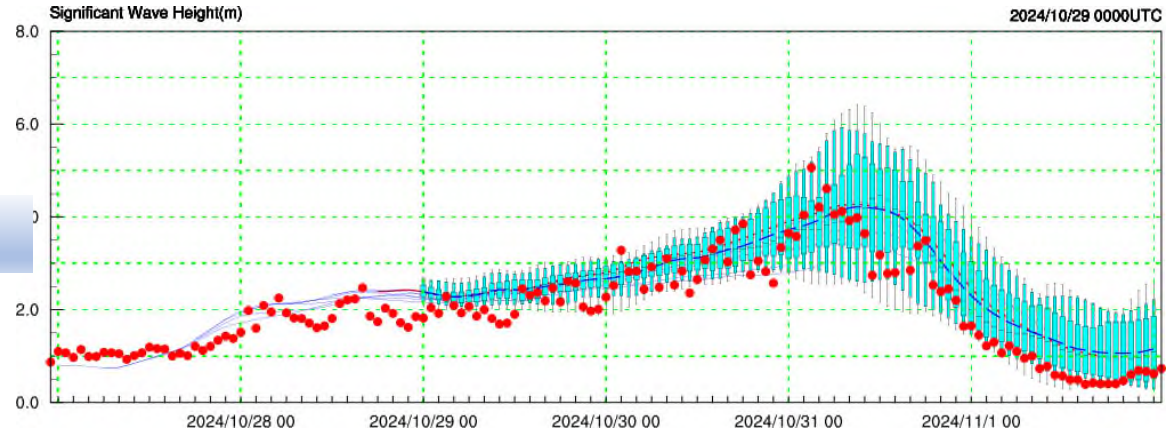


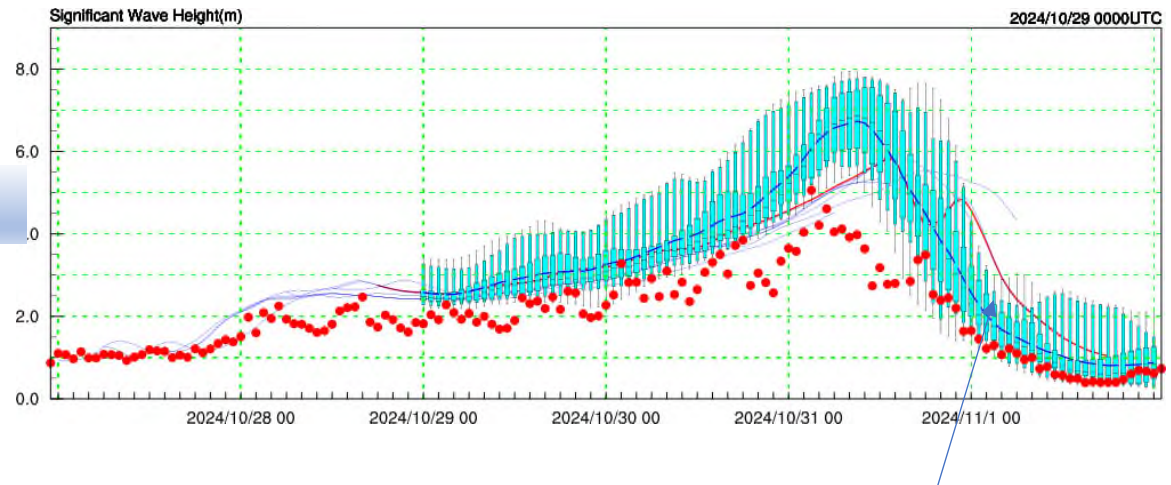


3.14

6.07

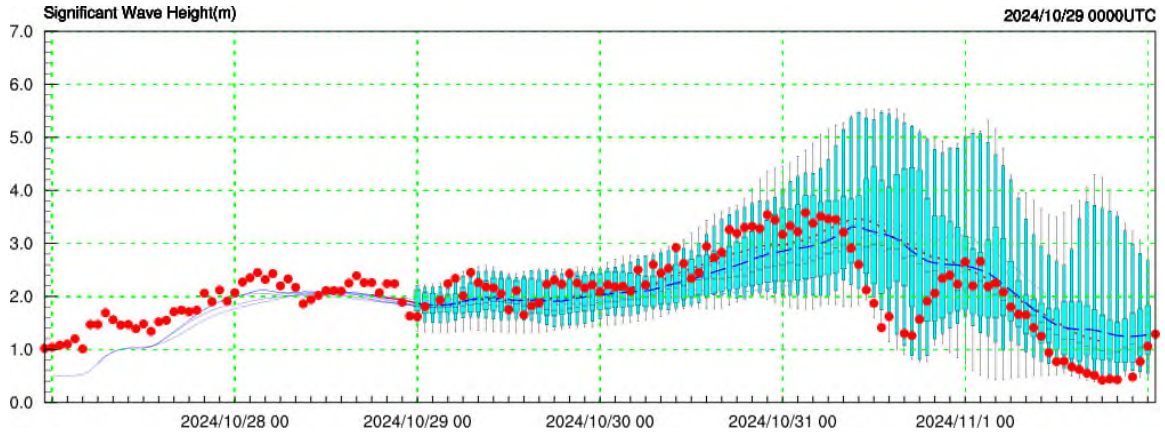
澎湖測站(46735A)

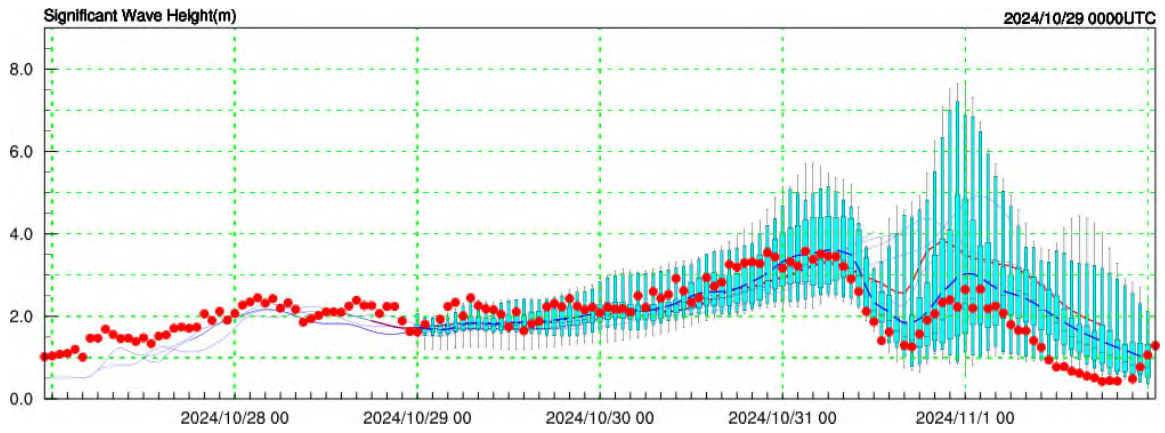




➢ 新版看的出來人為調整的痕跡

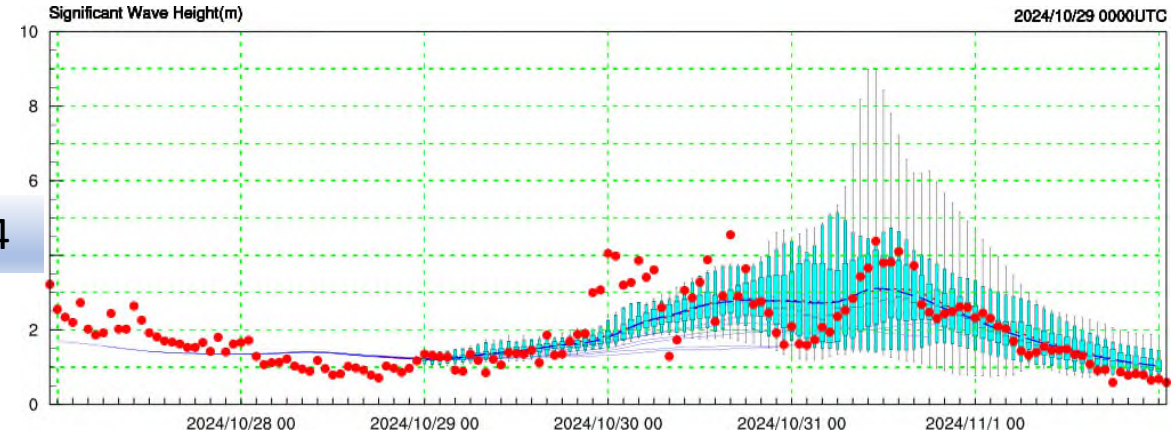
新竹測站(46757B)





鵝鑾鼻測站(46759A)

3.14



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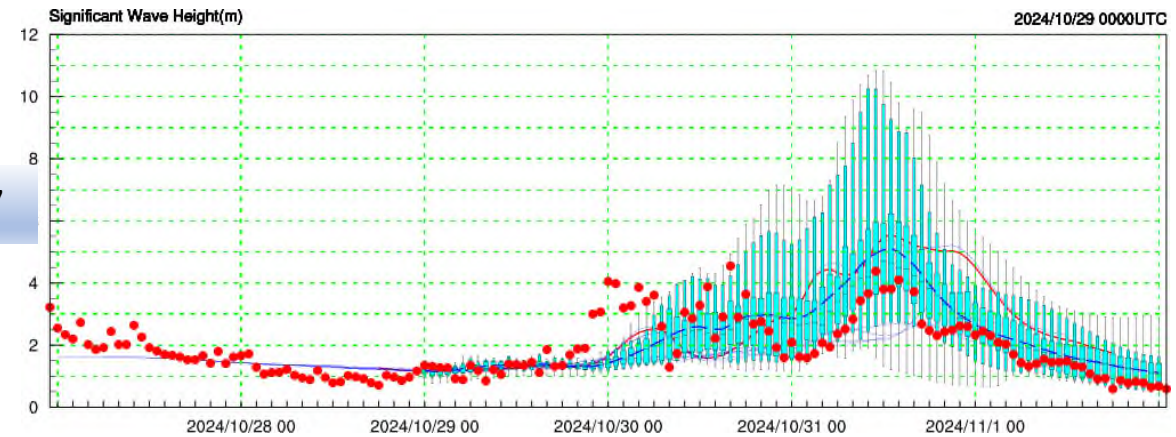
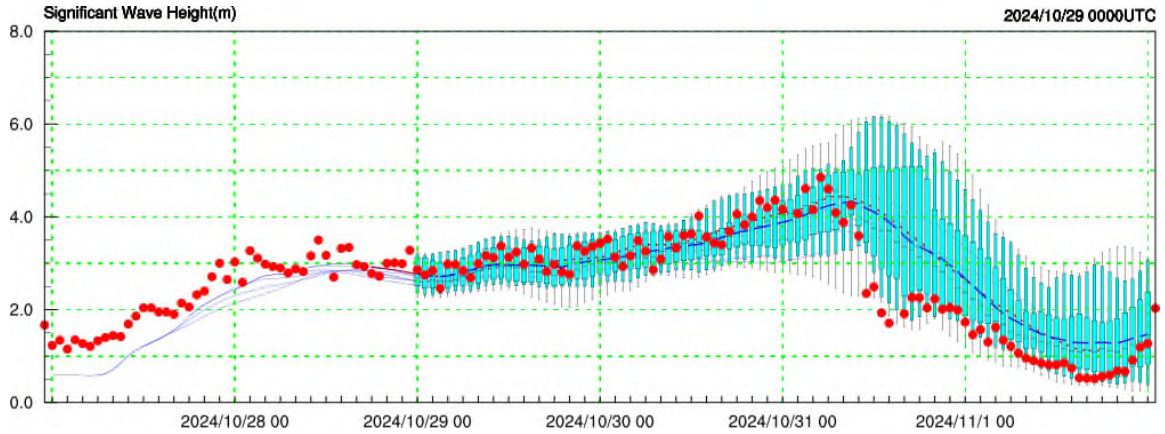


臺中測站(C6F01)



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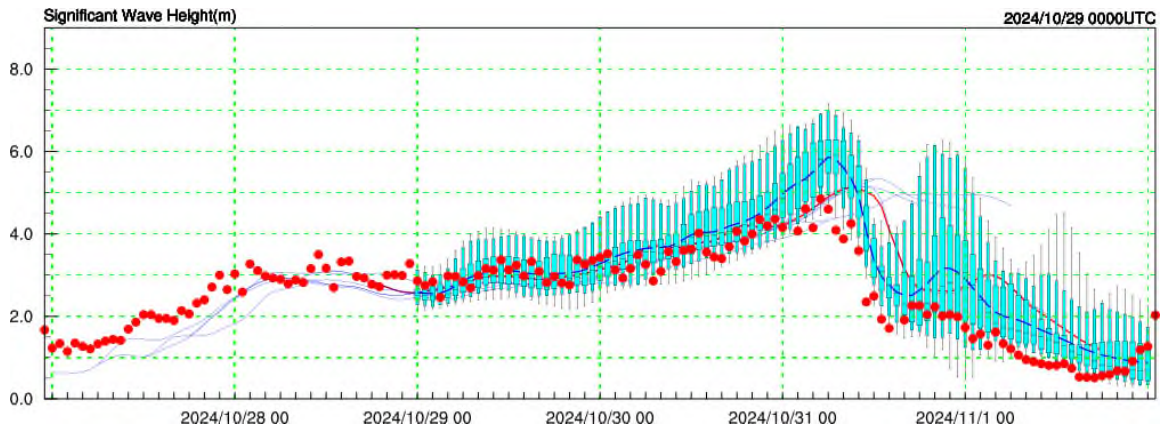
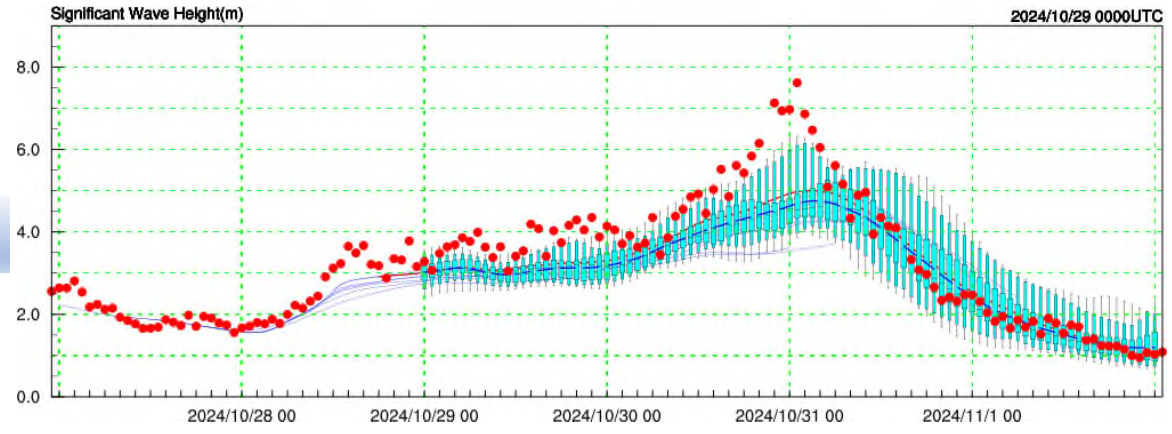


東沙島測站(C6V27)



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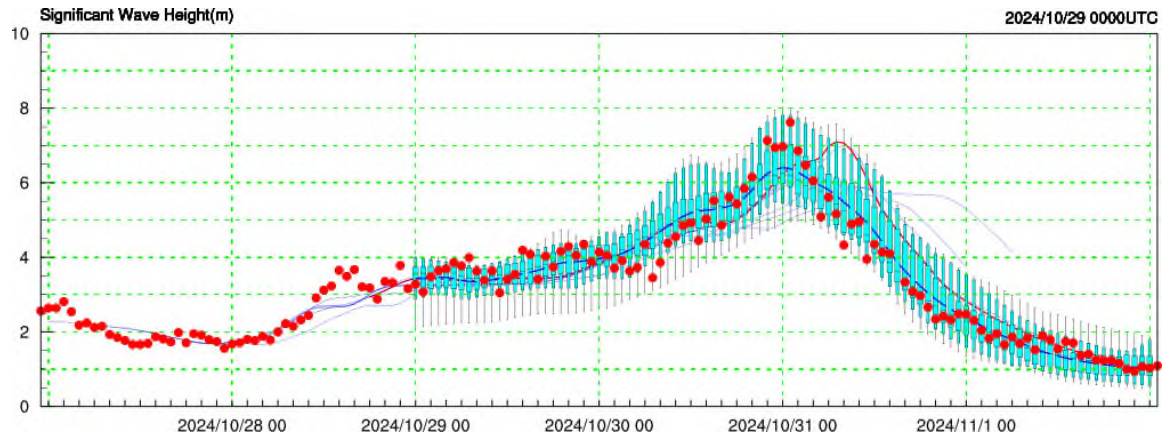
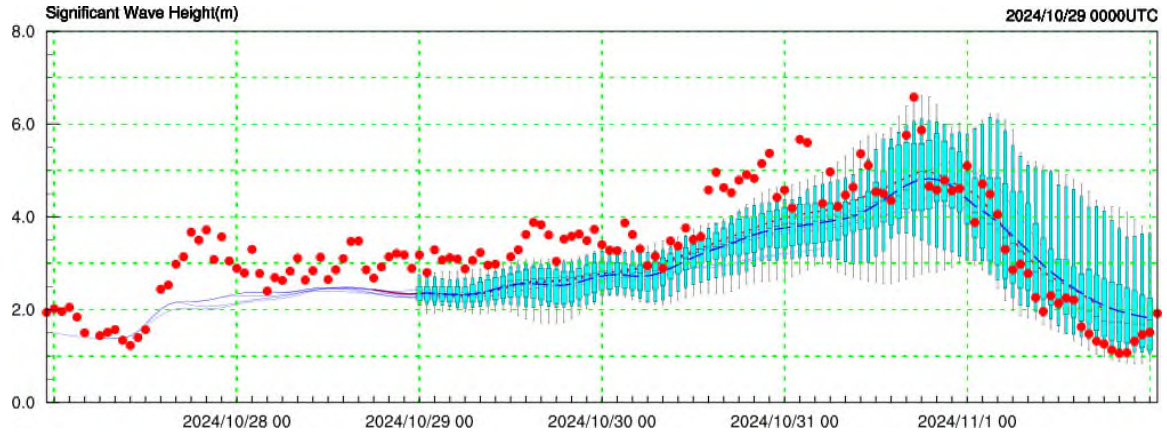
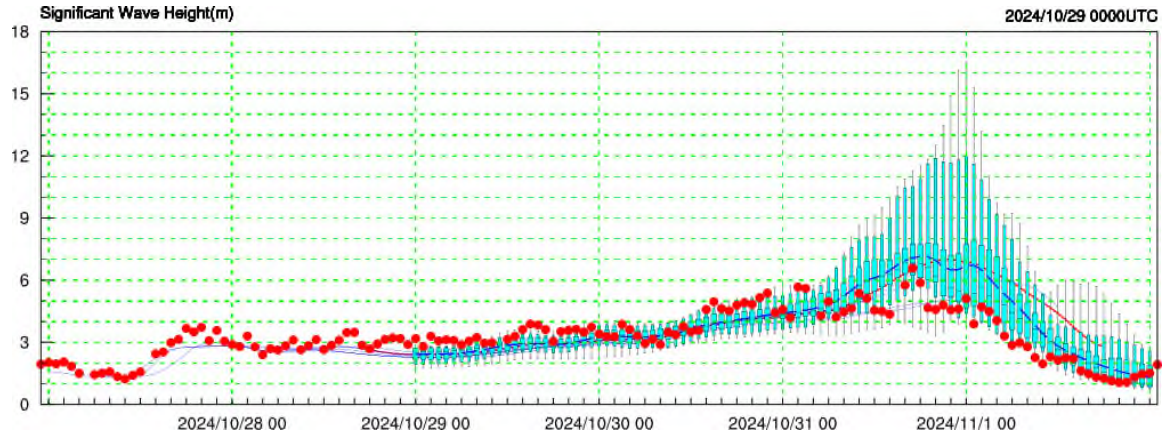


馬祖測站(C6W08)





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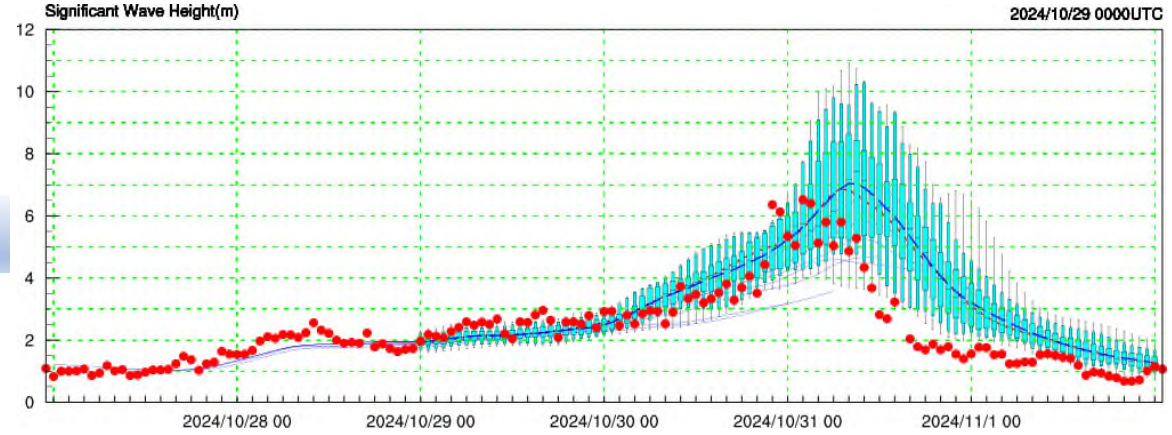
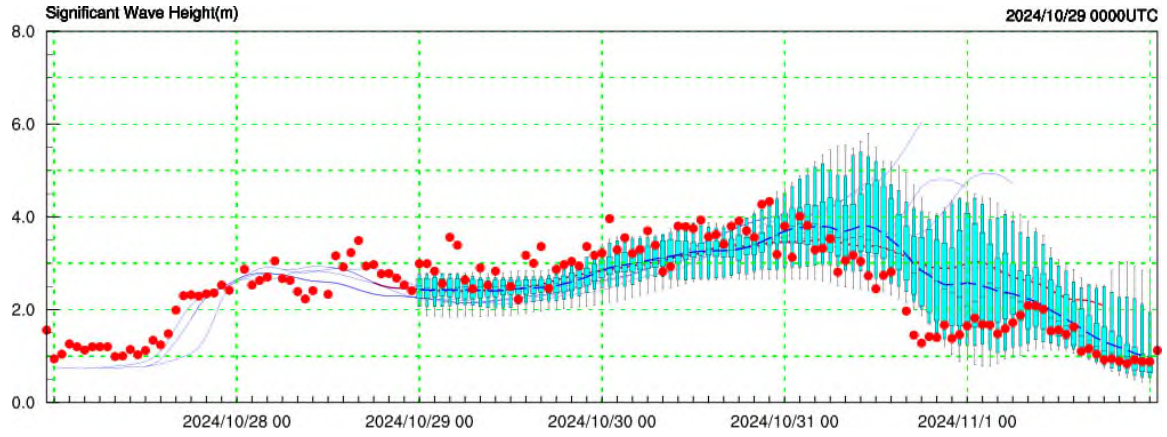
6.07

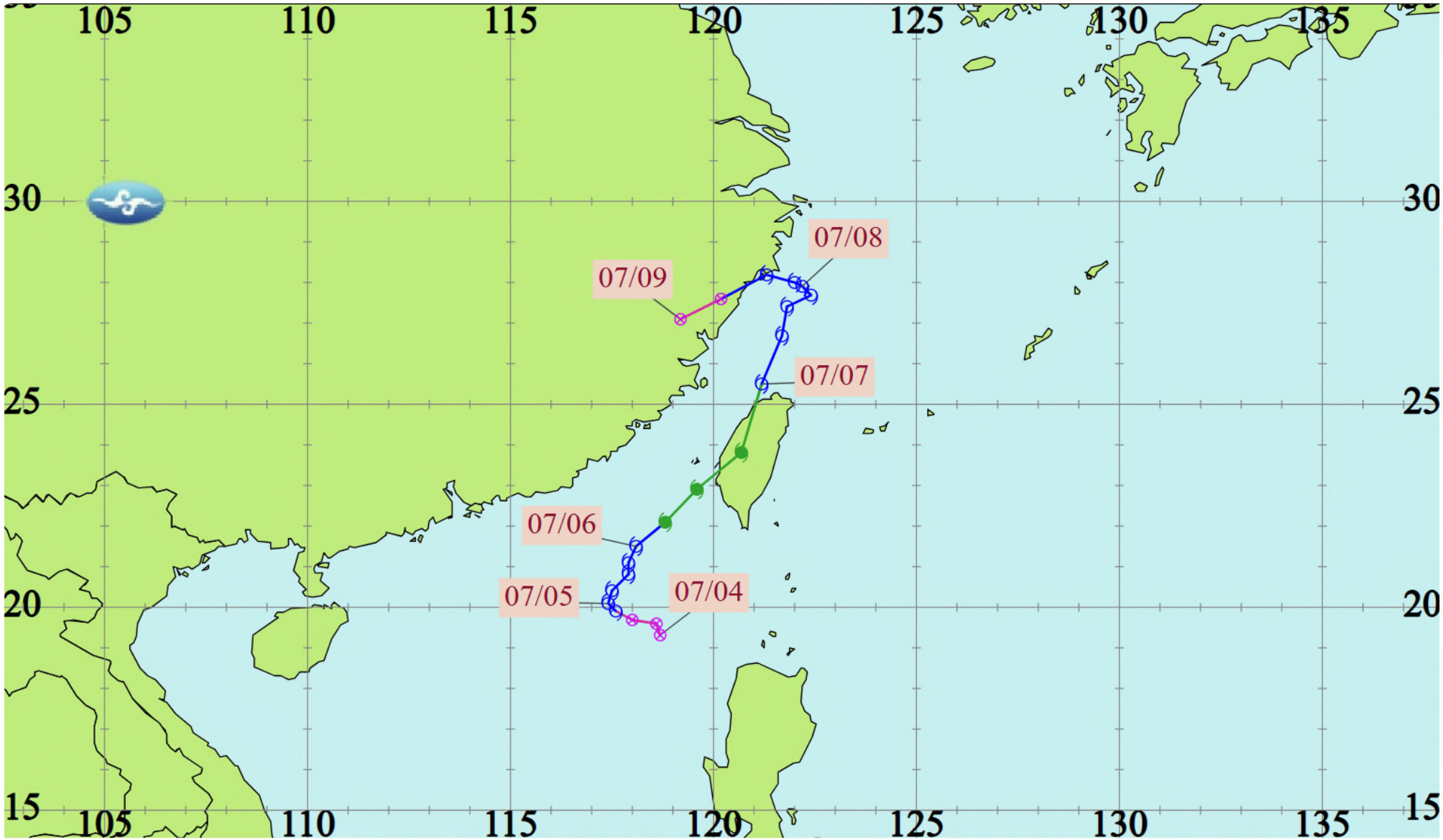
富貴角測站(C6AH2)





- 颱風期間優於舊版，但也導致過去48小時的系集平均存在較大差異，與人工編修的切入時間點有關

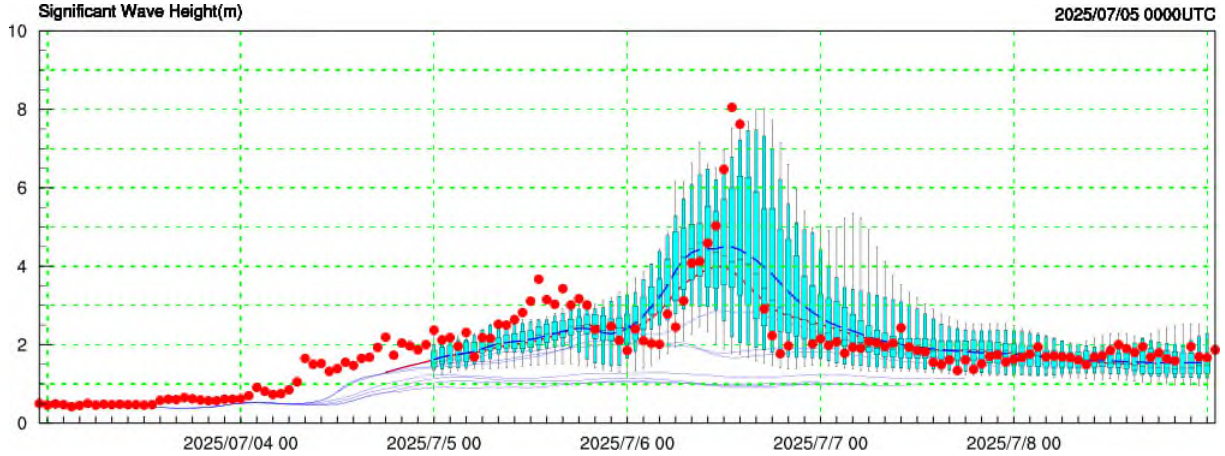
202504 丹娜絲(DANAS)

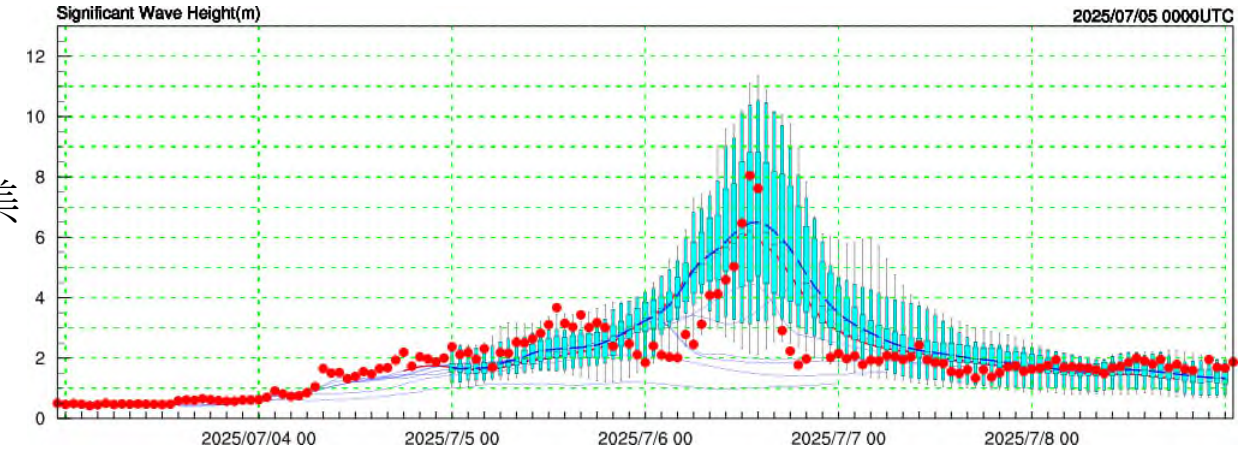


OLD

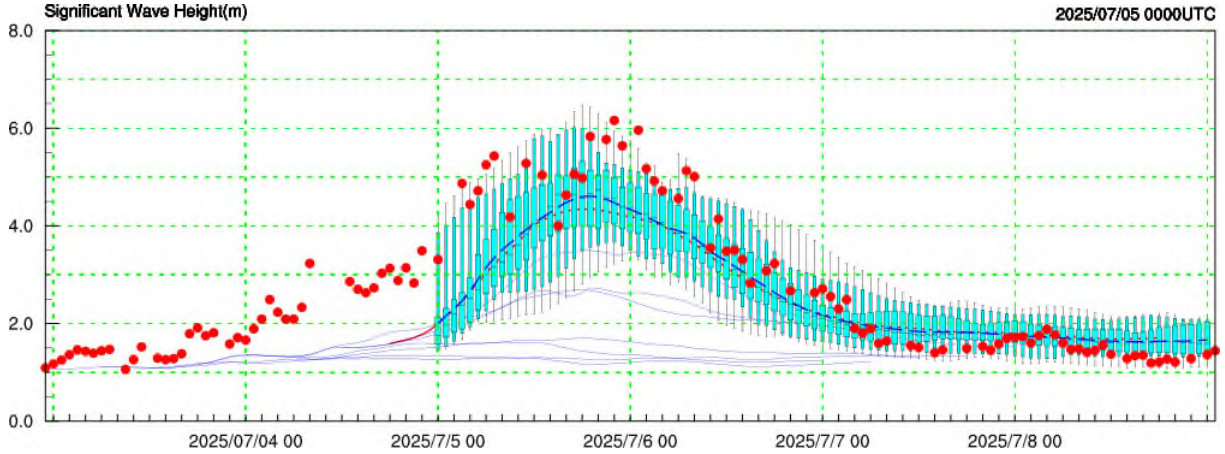
NEW

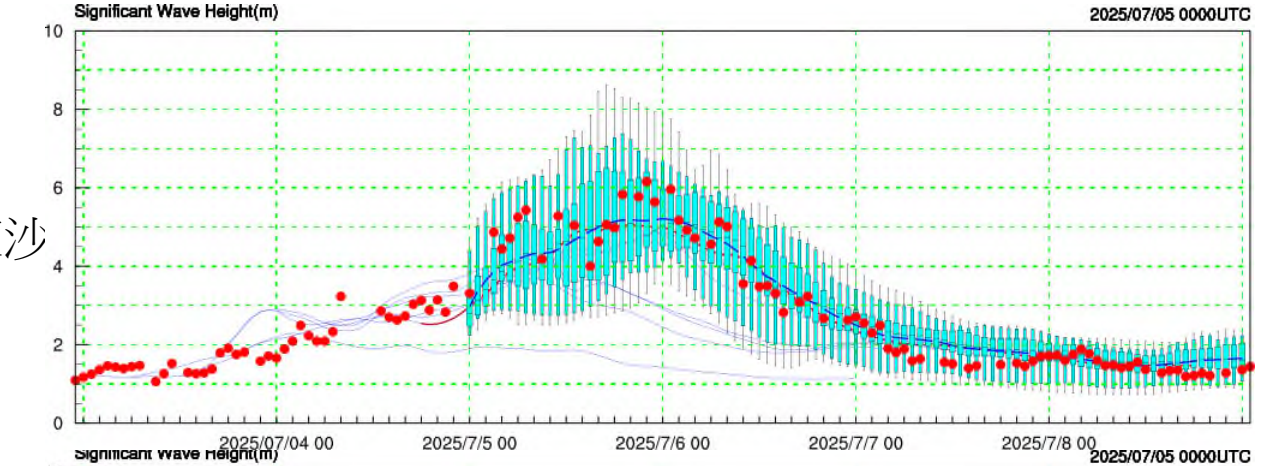
七美





東沙





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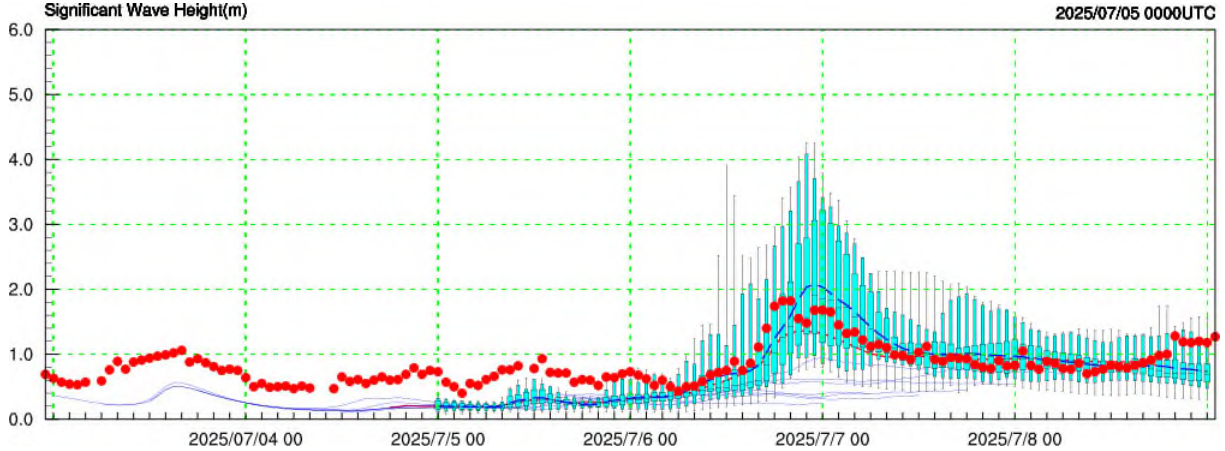

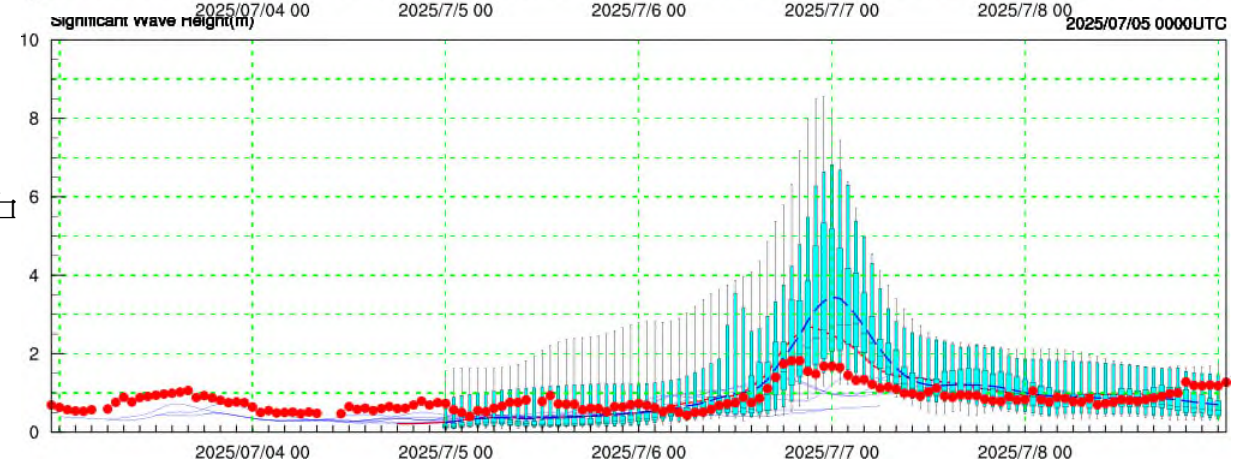

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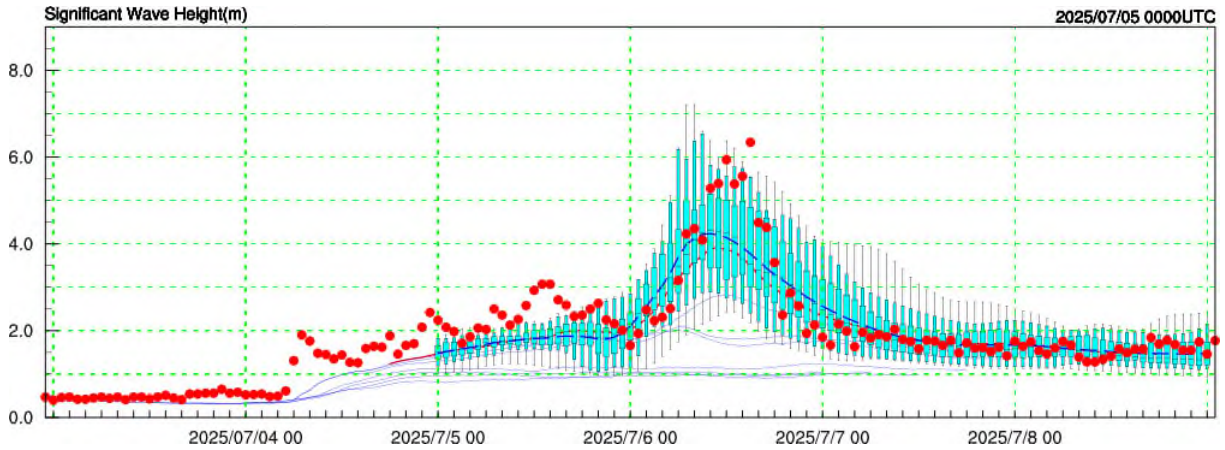
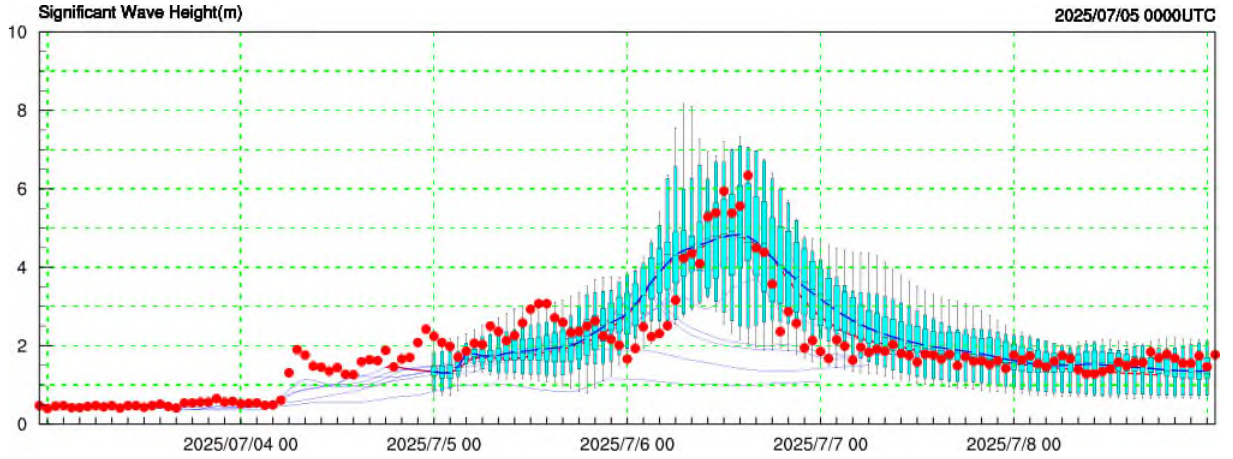
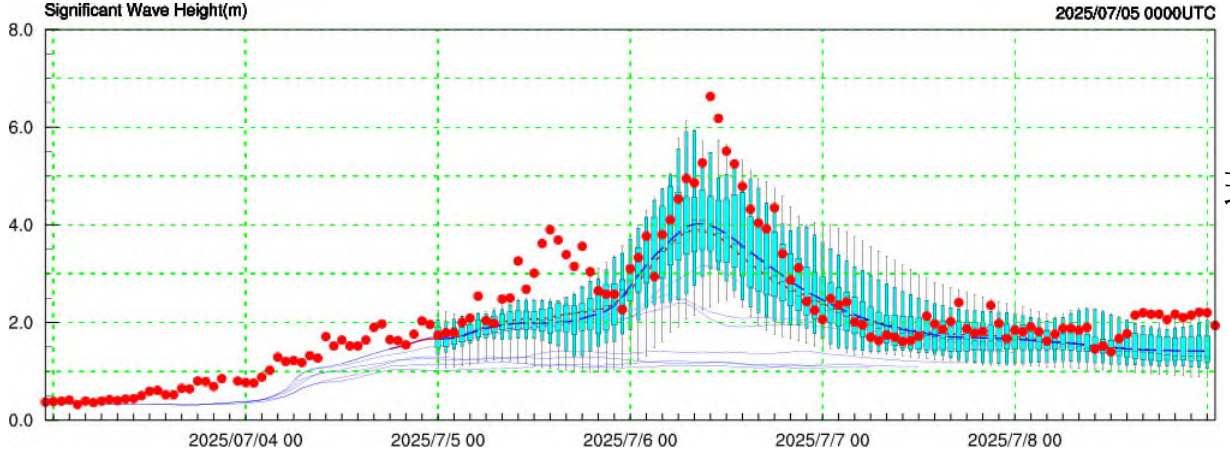
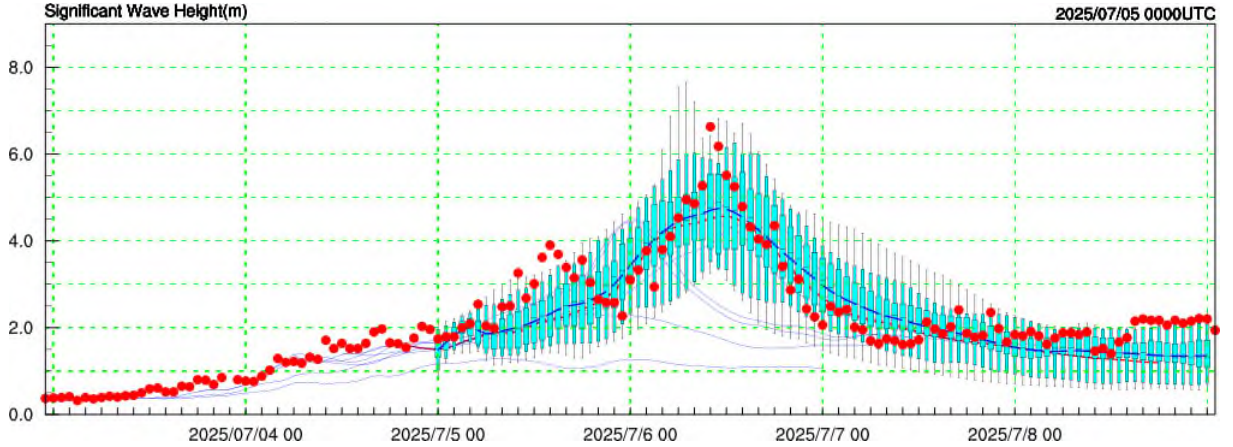


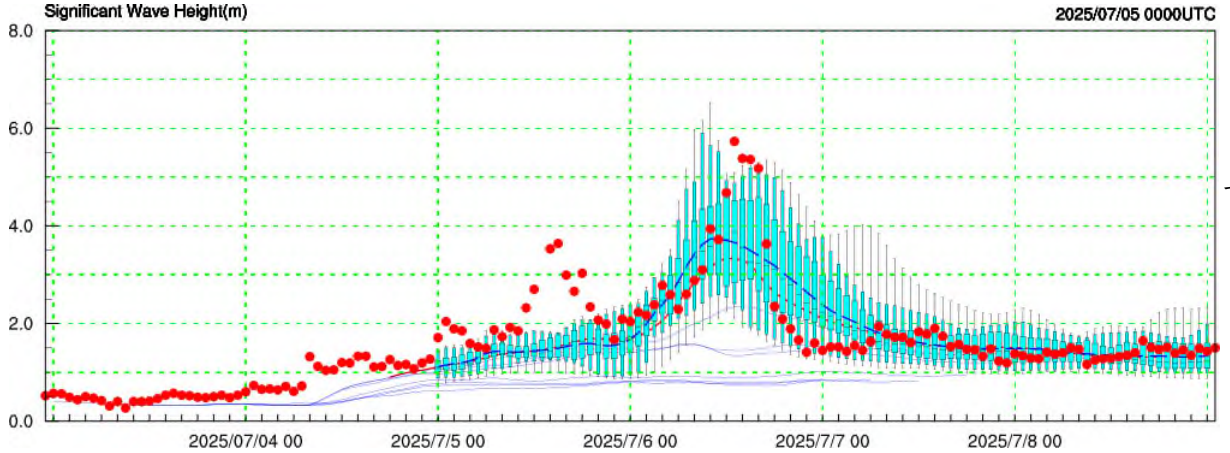
彌陀





琉球





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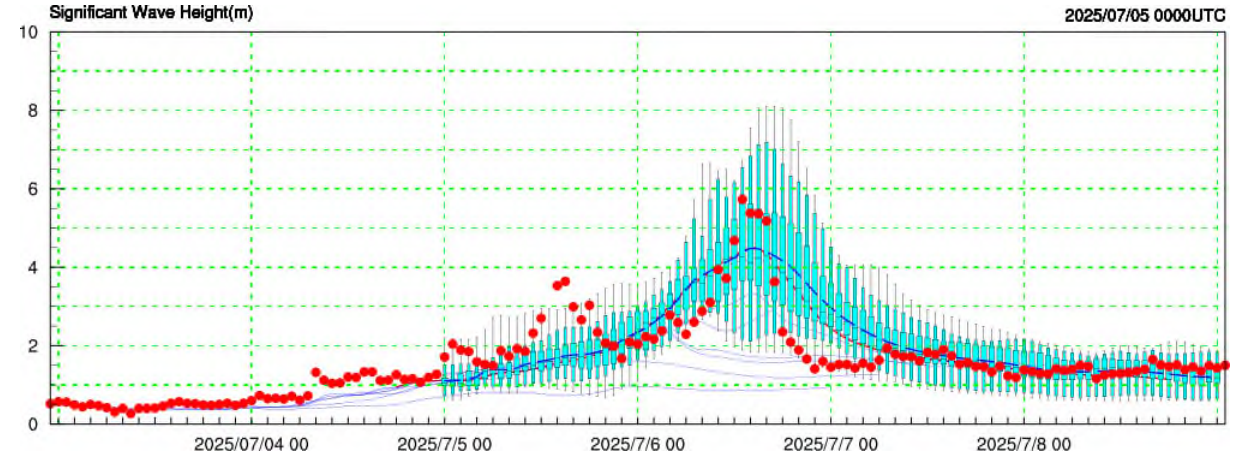

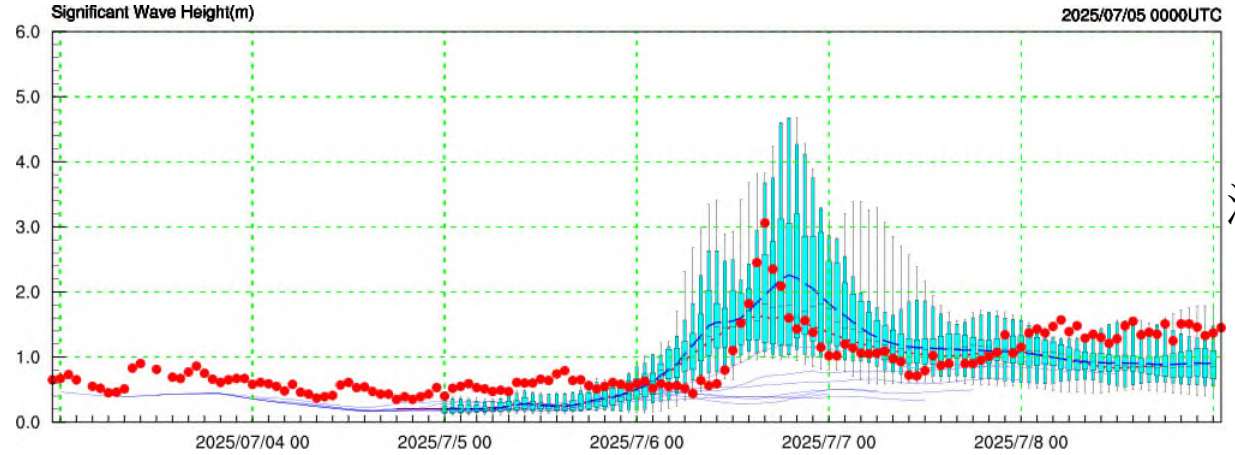
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4.0
3.0
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2025/7/5 00
2025/7/6 00
2025/7/7 00
2025/7/8 00

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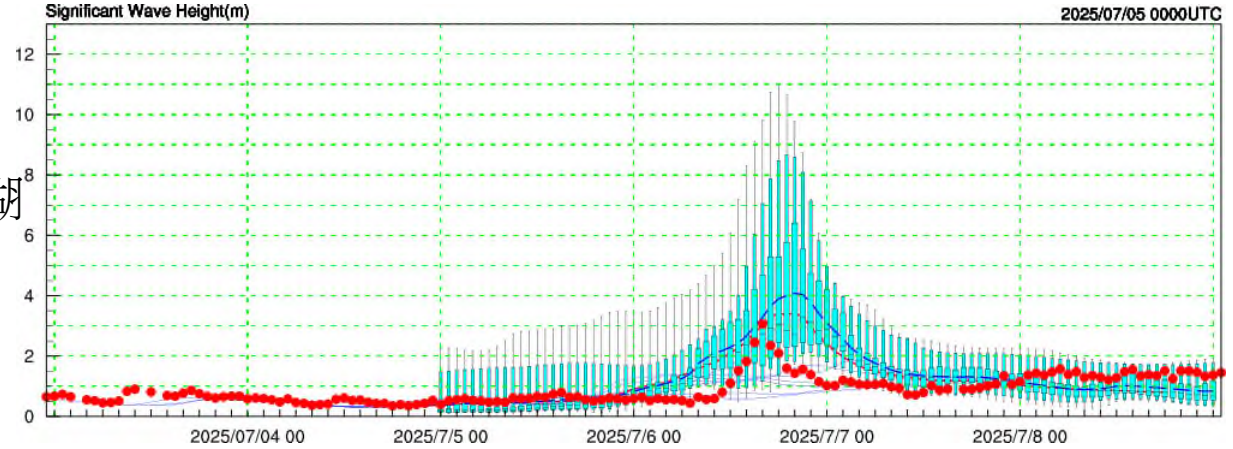
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0
2025/07/04 00
2025/7/5 00
2025/7/6 00
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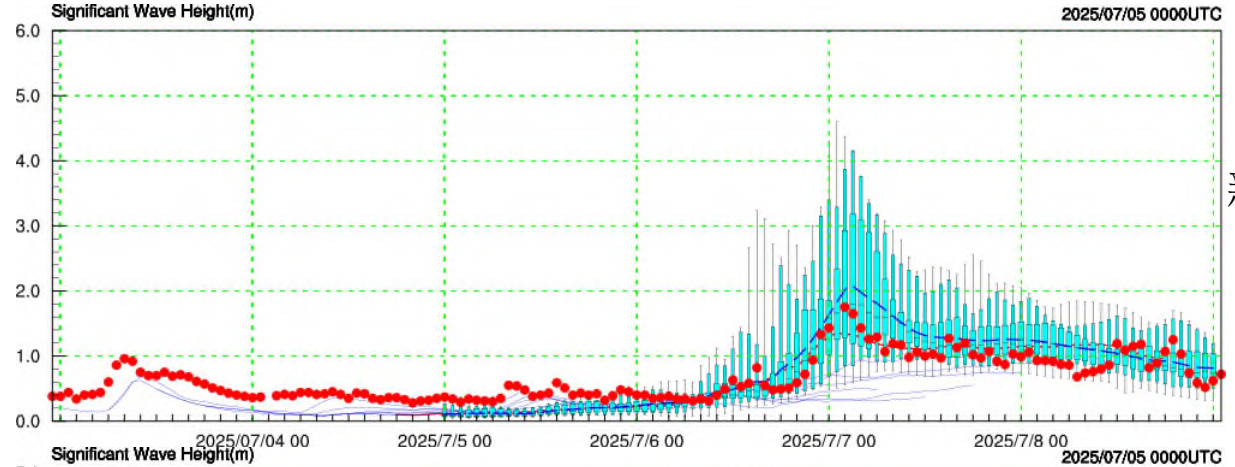
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2025/7/6 00
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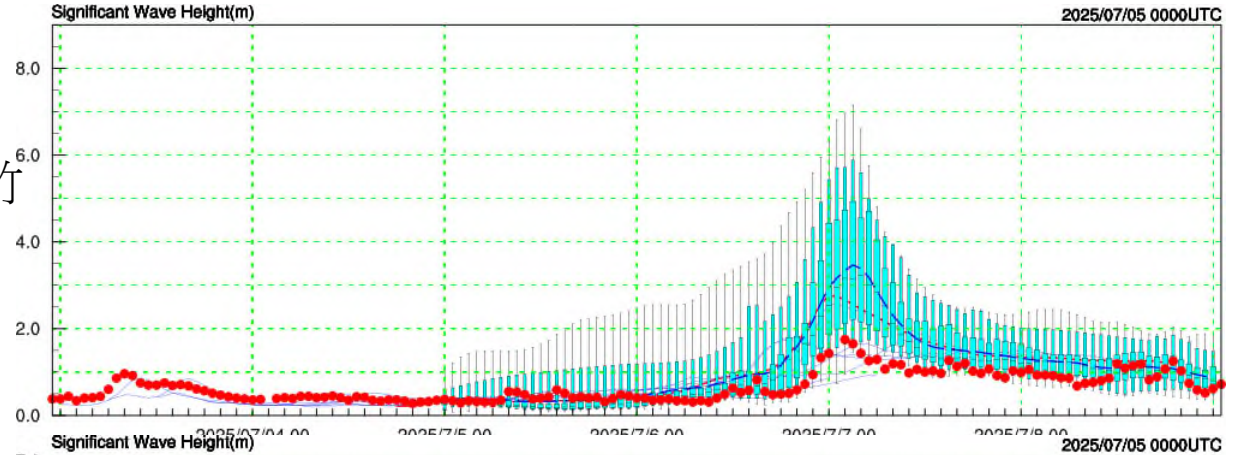
新竹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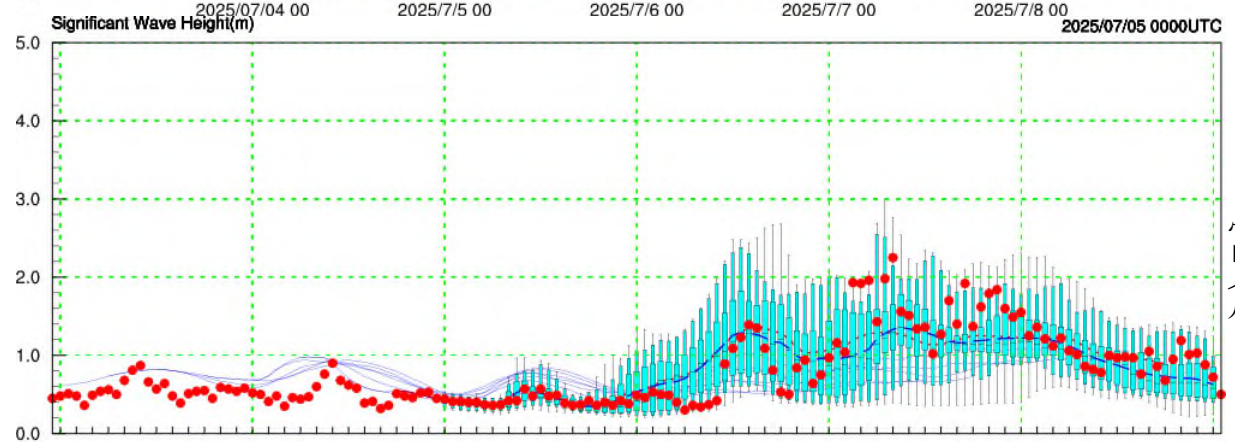
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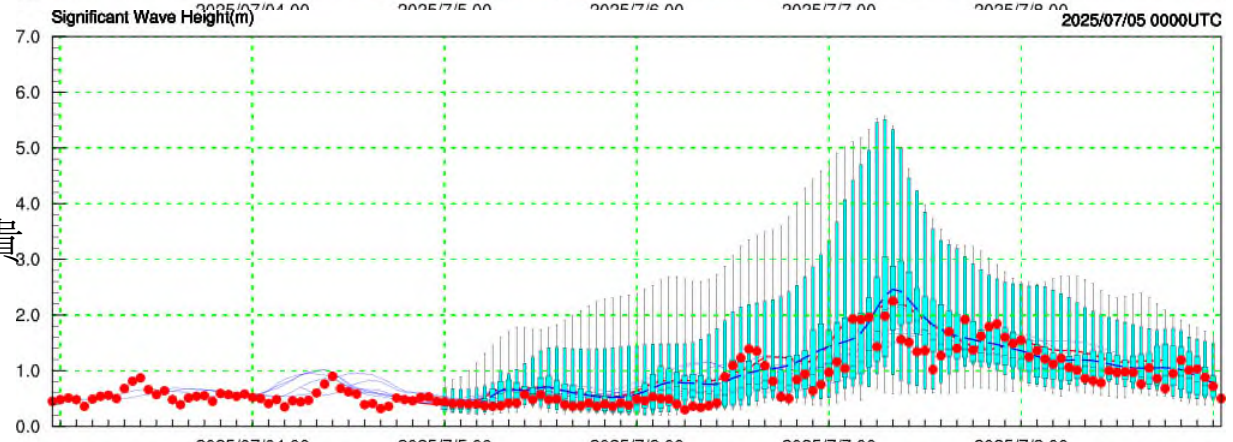
0.0

富貴角


Significant Wave Height(m)
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6.0
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4.0
3.0
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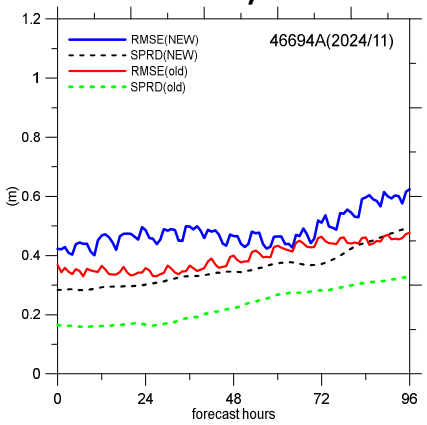
1.0
0.0

龍洞

2024/11



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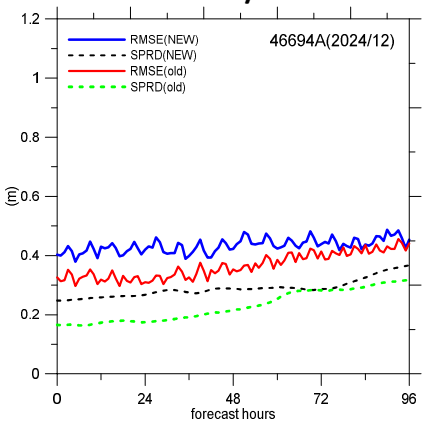

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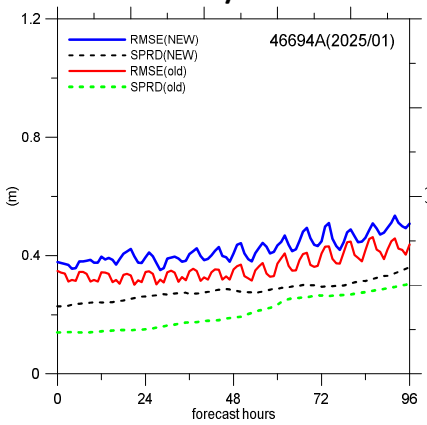
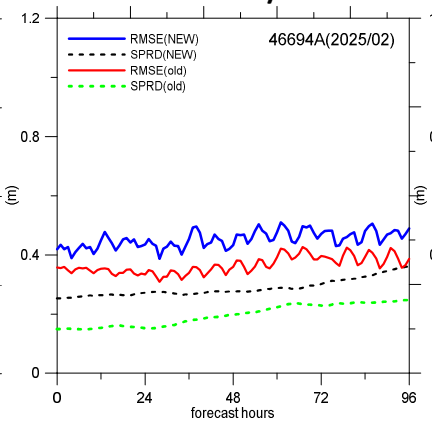


2025/02



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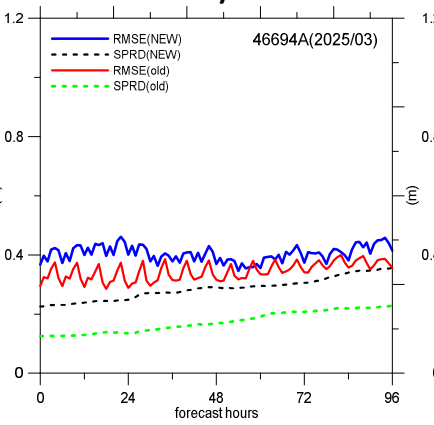

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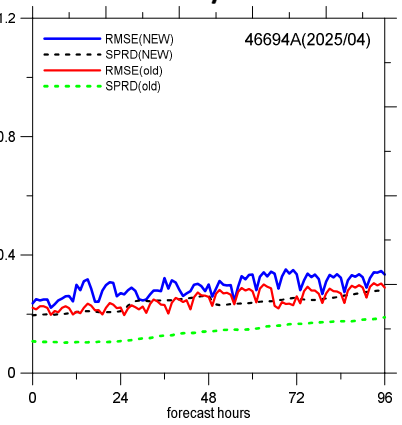
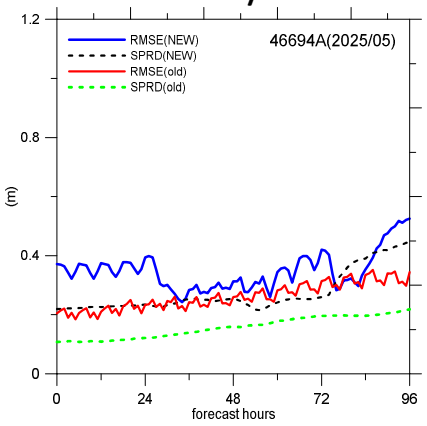


2025/05

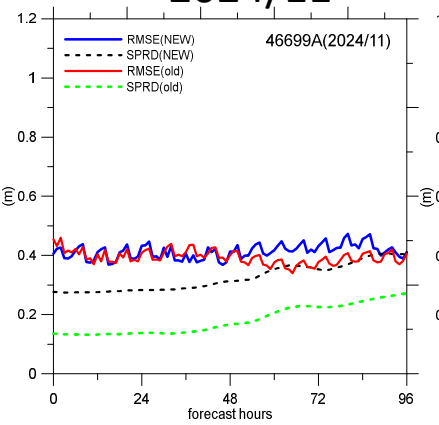


藍色實線為新版RMSE、黑色虛線為新版系集分岐

紅色實線為舊版RMSE、綠色虛線為舊版系集分岐

花蓮

2024/11



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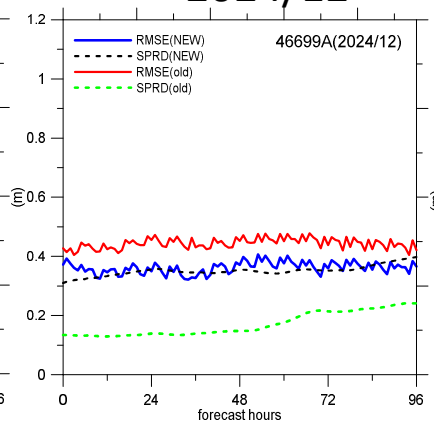

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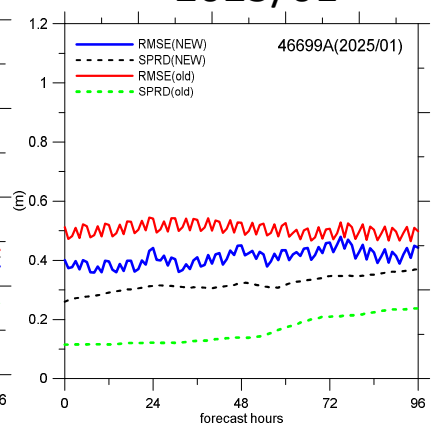

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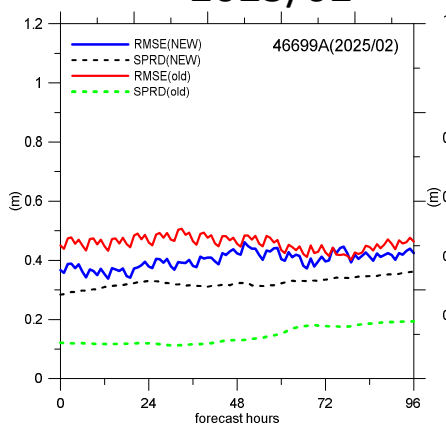

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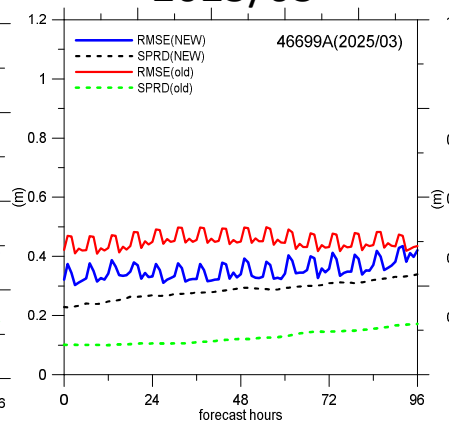

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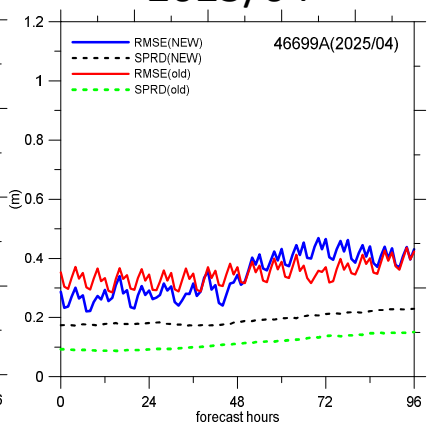

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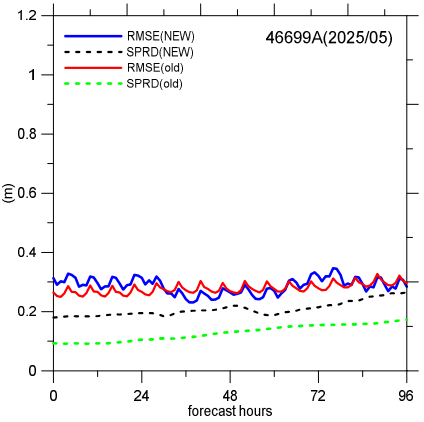
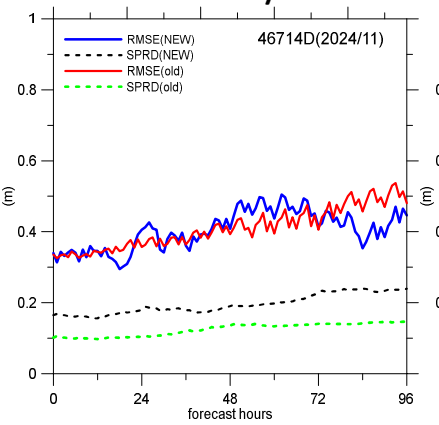


藍色實線為新版RMSE、黑色虛線為新版系集分岐

紅色實線為舊版RMSE、綠色虛線為舊版系集分岐

小琉球

2024/11



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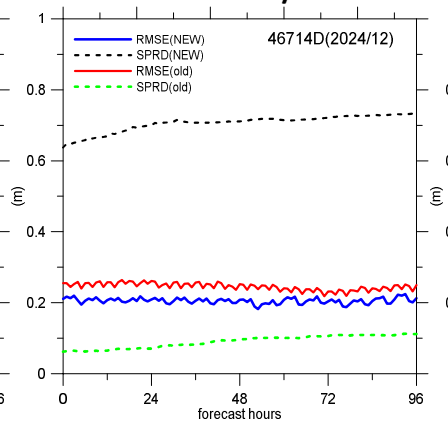

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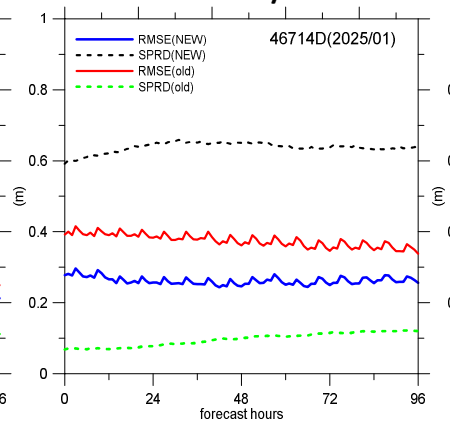

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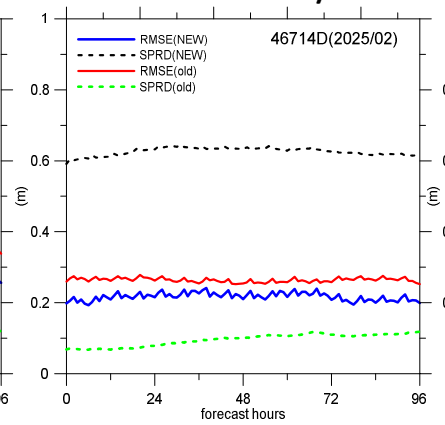

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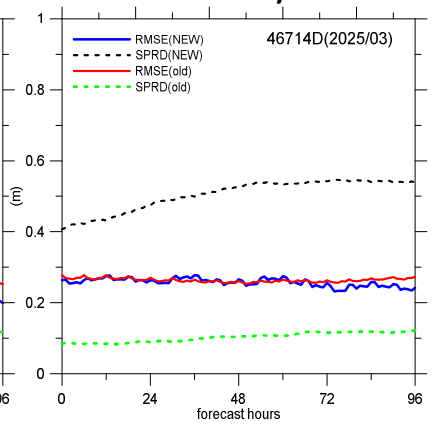

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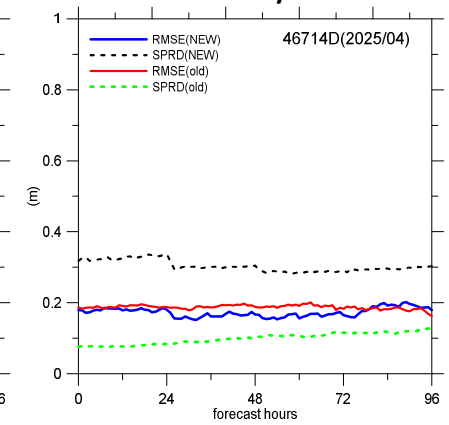

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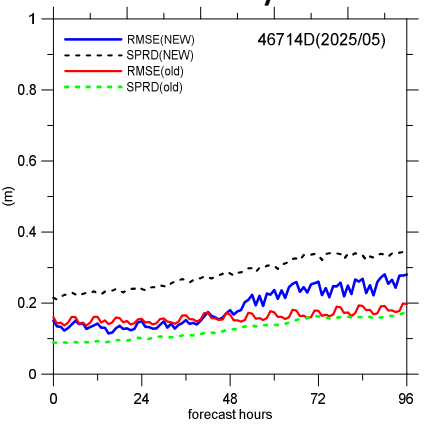

藍色實線為新版RMSE、黑色虛線為新版系集分岐

紅色實線為舊版RMSE、綠色虛線為舊版系集分岐

初步結論

- 新的Recenter風場可以提高波浪預報數值及系集分岐，但在不同海域顯現不同的特性趨勢
  - 東北部測站及蘭嶼測站RMSE亦普遍增加，使得系集分岐普遍小於RMSE的現象並未顯著改善;
  - 東部花蓮和台東二測站，除了5月新版顯示較優的預報結果;
  - 西部測站除了台中外，包括七美和金門測站，在12月至隔年3月(小琉球還有4、5月)，SPRD明顯大於RMSE，均表示過度離散。
  - 馬祖、澎湖、台中測站新版大致均優於舊版，但較優方式不一樣，馬祖為RMSE變小，澎湖與台中為RMSE與SPRD接近。
- 預報中心風場在台灣海峽有預報偏高的趨勢，是否是造成波浪預報離散過大的主因，仍待進一步探討。