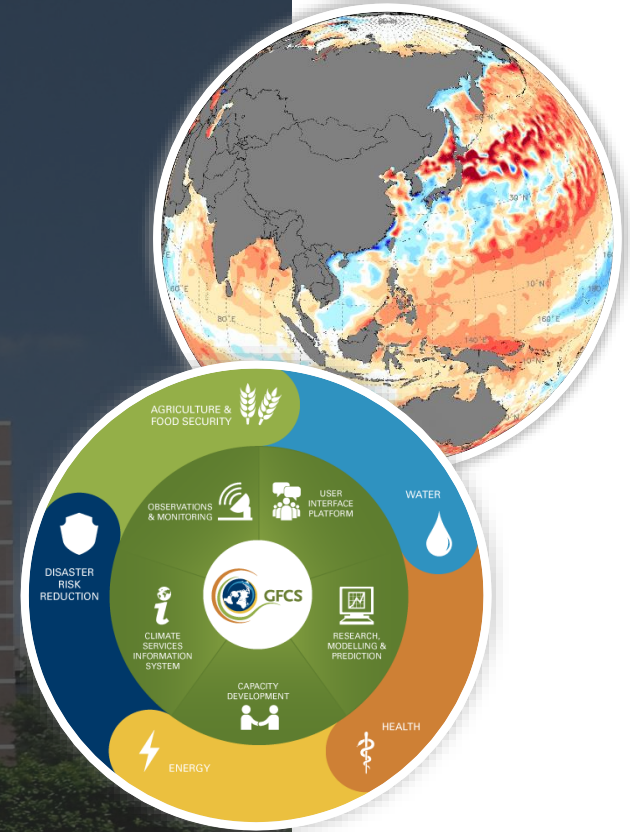




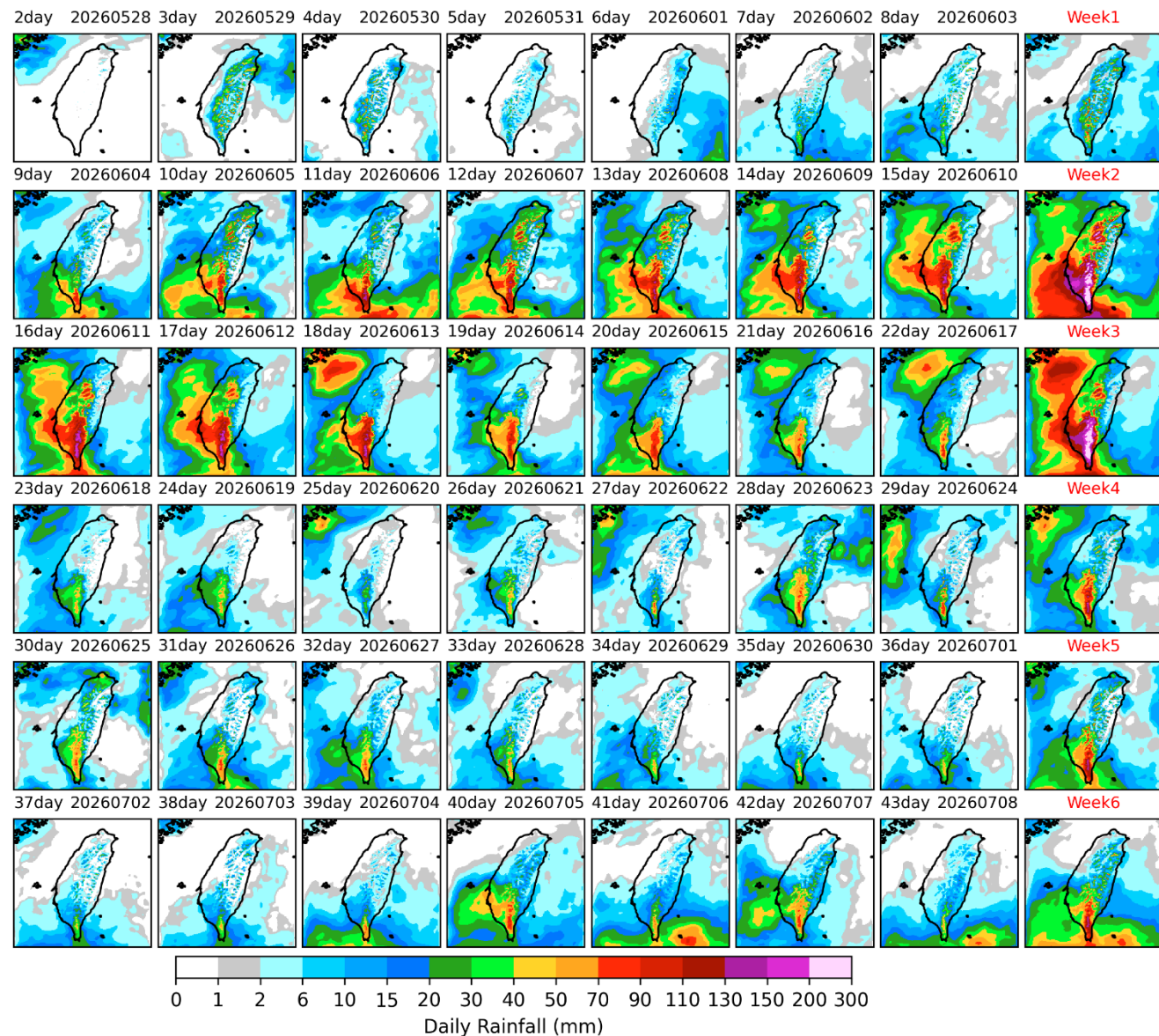
展期預報提供高解析網格日尺度降雨預報之可行性評估

中央氣象署

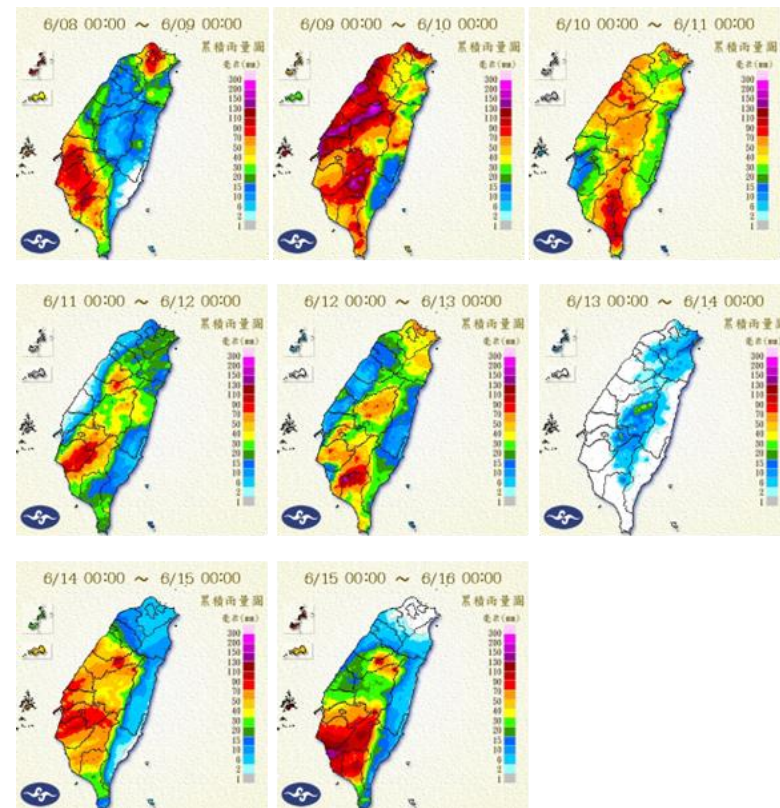
陳昀靖，羅資婷，李清滕



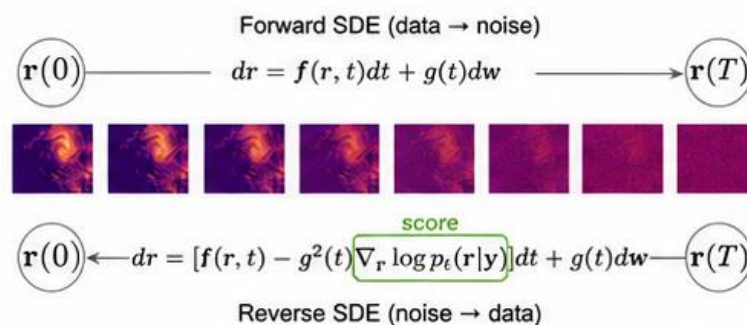
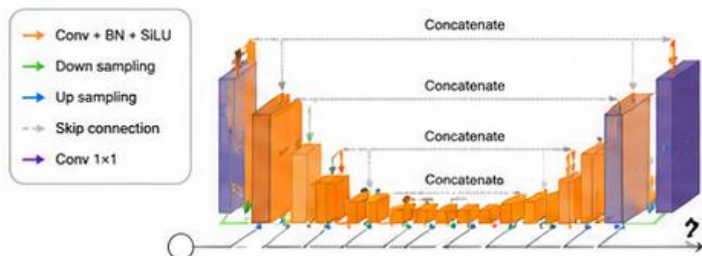
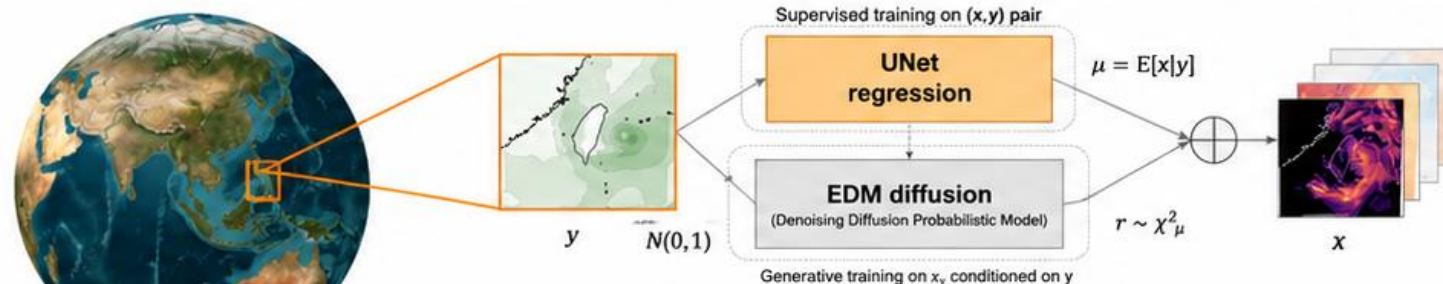
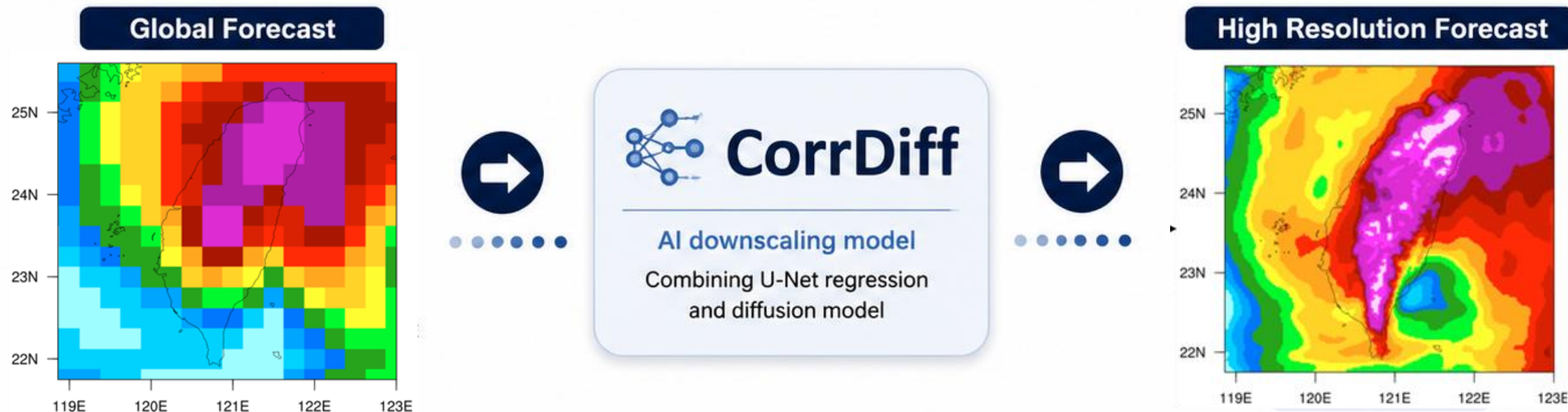
EC – CorrDiff 逐日降雨預報 初始時間 20260526



0608 – 0615 觀測降雨



AI-based Downscaling



Training DataSet



Global data: ERA5 reanalysis
25-km resolution



Regional data: TReAD
(Taiwan Reanalysis Downscaling data)
2-km resolution



Training Period
1991 - 2023

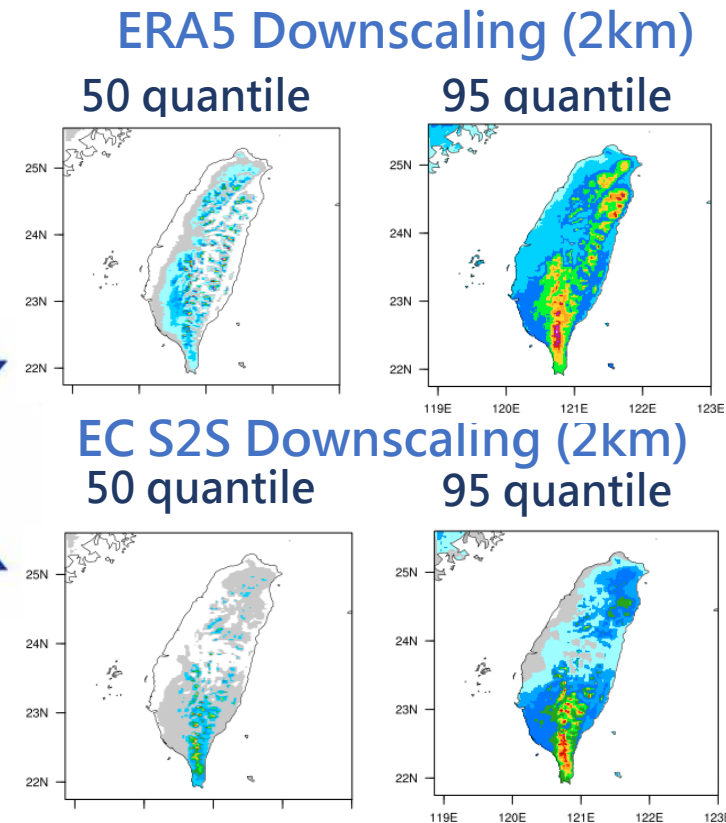
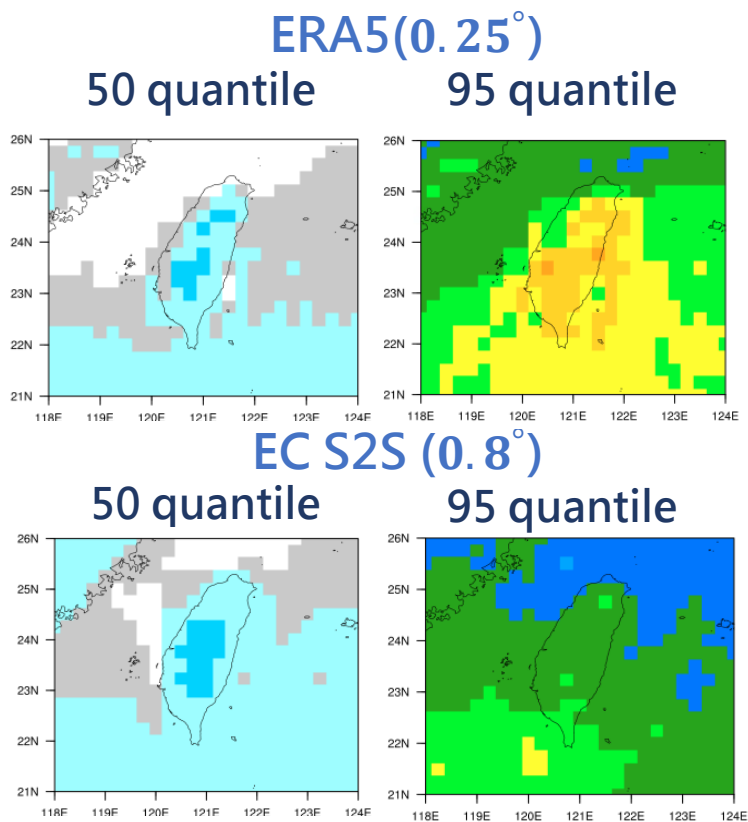
偏差校正重要性



Forecast Dataset

Mode : EC S2S Reforecast
Lead time : Week3
Mon : 7 – 9 (颱風季)
Year : 2005 - 2024

- 全球模式資料統計特性與ERA5有差異
- 此差異也同步影響降尺度表現
- 模式資料輸入CorrDiff之前須偏差校正

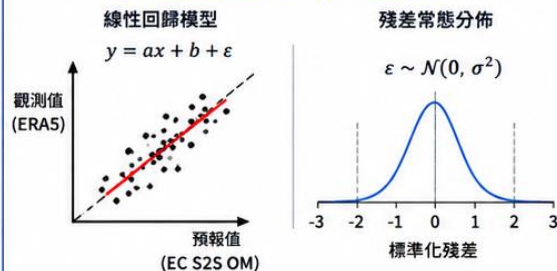


偏差校正效果



回歸常態分佈 + Copula

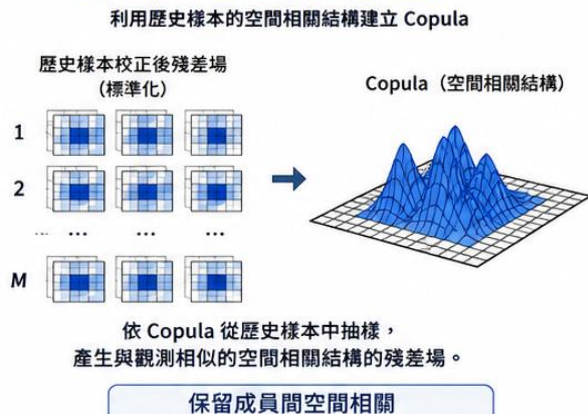
(1) 回歸常態分佈 (偏差校正)



將預測值 x 經回歸模型得到校正後的平均
再加上常態分佈的隨機誤差 ε ，使校正後
分佈與觀測具有相同的均值與變異。

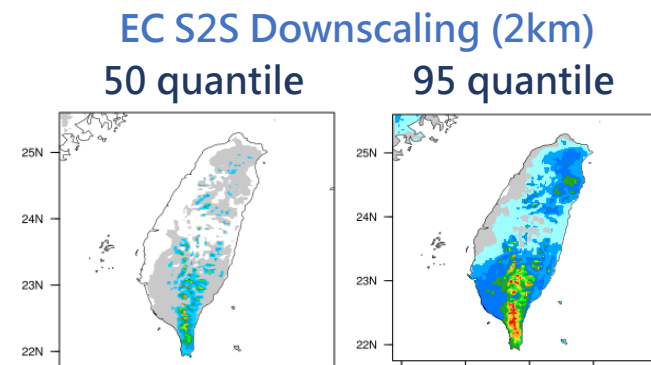
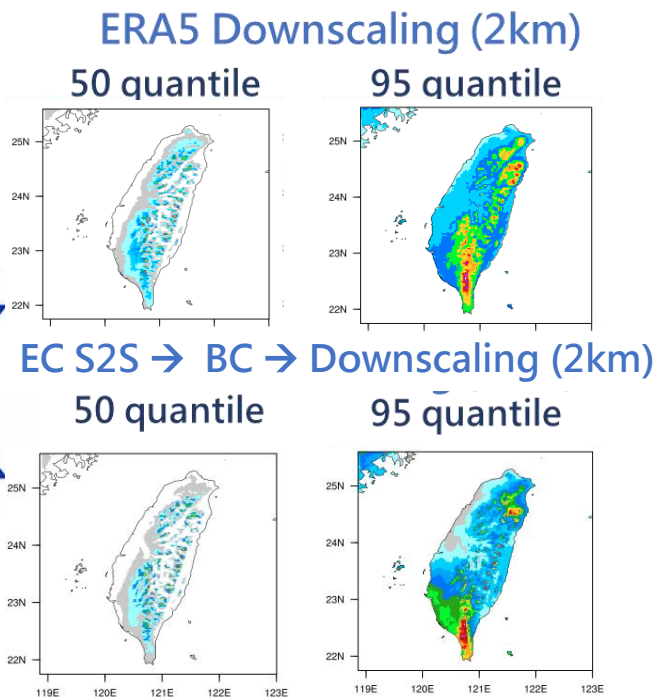
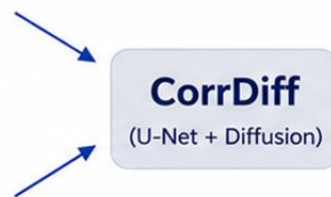
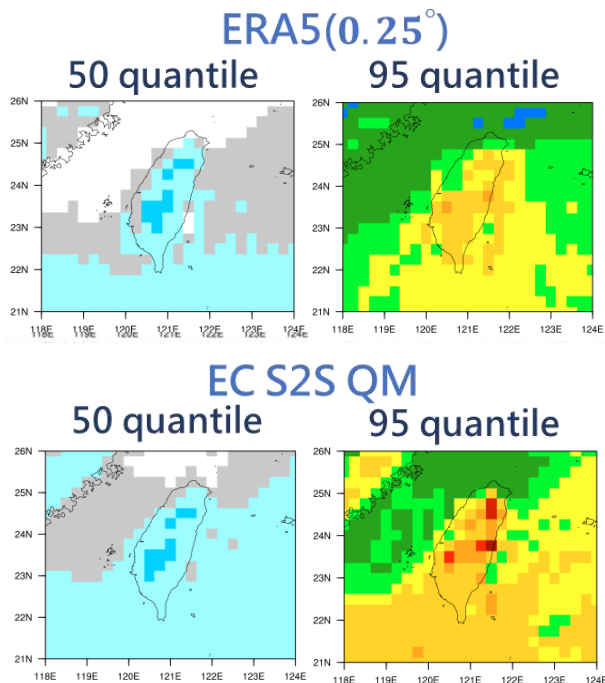
消除系統性偏差 (調整均值與變異)

(2) Copula 抽樣 (保留空間相關)



- 系統性偏差修正
- 空間保有模式本來的物理相關性
- 透過歷史資料調整出更合理的離散度

Training Period	Valid Period
2005 – 2019	2020 – 2024
2005 – 2014 & 2020 – 2024	2015 – 2019
2005 – 2009 & 2015 – 2024	2010 – 2014
2010 – 2024	2005 – 2009



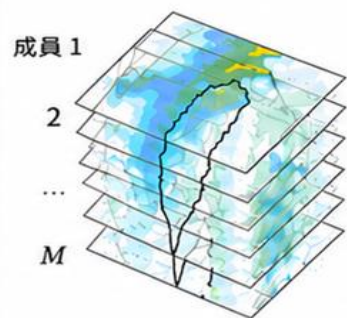
AI-based 降尺度極端降雨預報流程



Forecast & Bias Correction

1

EC S2S 預報 (原始系集預報)

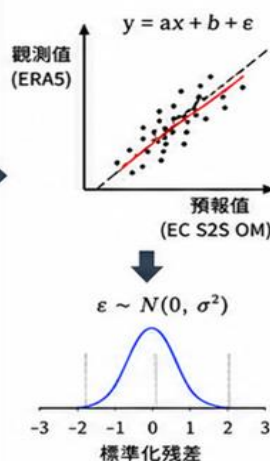


- 解析度：約0.25°
- 多個系集成員
- 預報週期：
Week 3 (Day 15–21)

2

回歸常態分佈 + Copula (同時校正分佈與保留空間相關)

(1) 回歸常態分佈 (偏差校正)

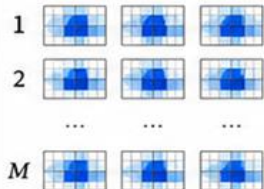


將預報值經線性回歸校正後，
殘差服從常態分佈，消除系統性偏差
並調整預報分佈。

消除系統性偏差
(調整均值與變異)

(2) Copula 抽樣 (保留空間相關)

利用歷史樣本的空間相關
建立 Copula



依 Copula 抽樣產生
具觀測相似空間結構的場

保留成員間
空間相關結構

重點：同時消除系統偏差
並保留成員之空間相關結構

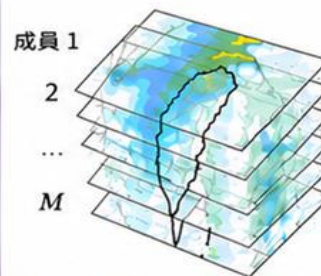
AI Downscaling

3

CorrDiff 降尺度 (AI 降尺度)



輸入：校正後系集成員 x^*



- 解析度：2 km
- AI 降尺度 (CorrDiff)
- 產生 2-km 高解析度
系集降雨預報

重點：AI 降尺度產生
高解析度降雨預報

Forecast Product

4

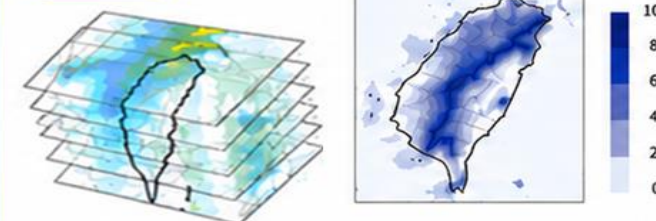
後處理與產品製作

極端降雨機率預報 (80 mm/day 門檻)

(事件機率預報)

依 TReAD 門檻 計算每個成員 產生 80 mm/day
達到 ≥ 80 mm/day 極端降雨機率
的發生機率

80 mm/day
(單日累積)



- 輸出：80 mm/day 極端降雨機率 (%)
- 時間範圍：Week 3 (Day 15–21)
- 空間解析度：2 km

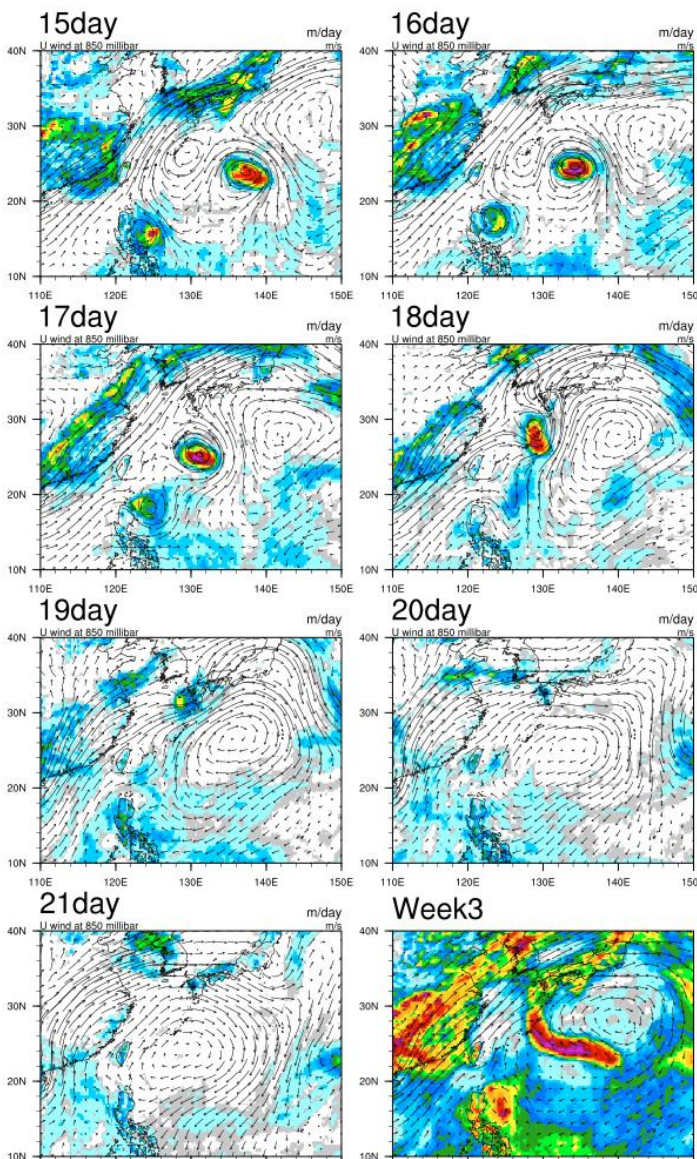
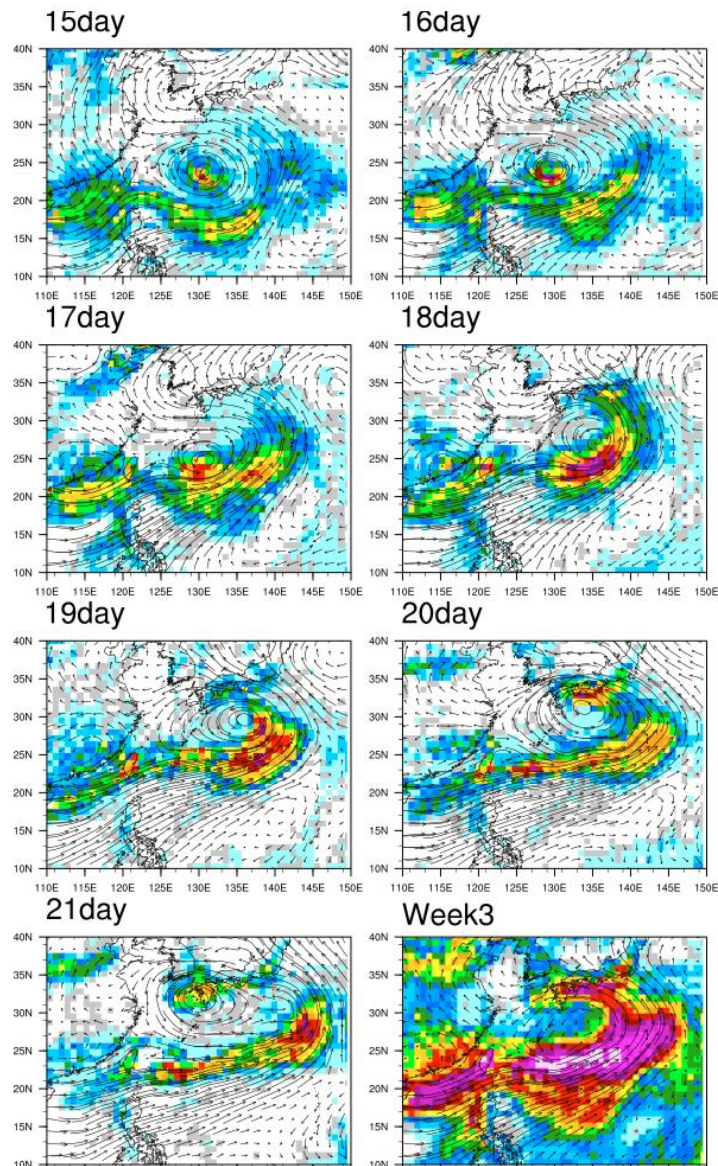
重點：提供極端降雨事件 (≥ 80 mm/day)
發生機率資訊

抓住大尺度趨勢，就能掌握極端事件的可能性



EC S2S

對應預報日期之ERA5



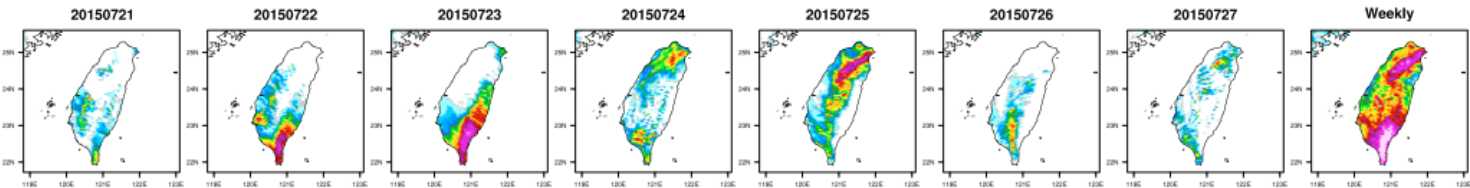
- EC 模式於第三週預報中，成功掌握到颱風外圍環流影響台灣的趨勢
- 颱風環流誘發西南風，導致台灣中南部出現顯著降雨
- 模式預報該週颱風活動活躍；雖然具體位置與影響日期略有偏差，但台灣在該週內出現豪大雨的機率依然偏高
- 當「週尺度」的趨勢預報準確時，該週內發生相應「日尺度」天氣事件的機率也隨之大幅提升。



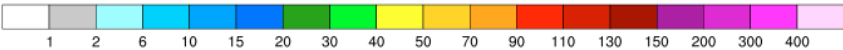
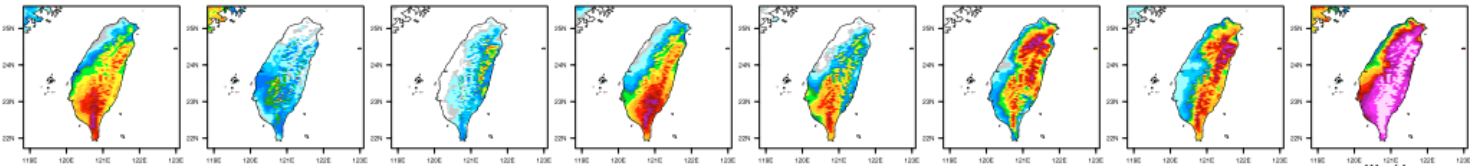
Forecast PRECIP

Day 15 Day 16 Day 17 Day 18 Day 19 Day 20 Day 21 Weekly Sum

OBS

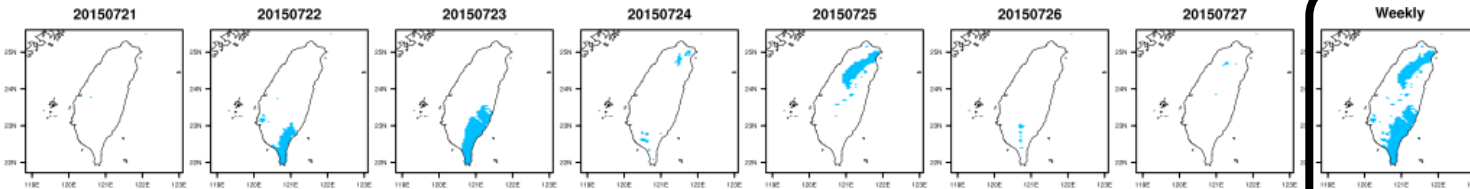


BC-Corrdiff

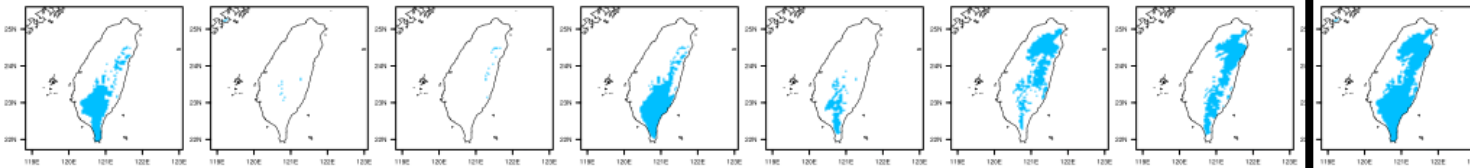


Forecast PRECIP ≥ 80 mm Area

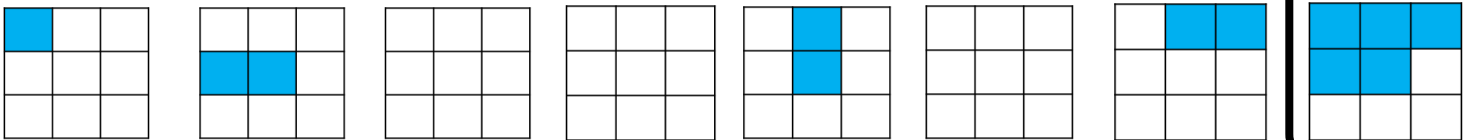
OBS



BC-Corrdiff



example



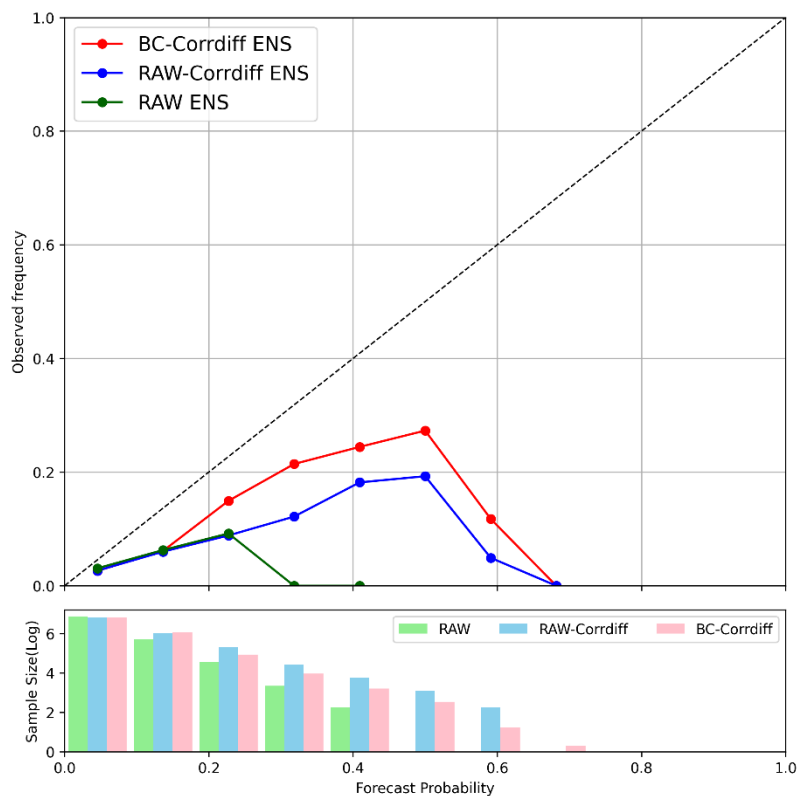
Areas Where the Event Occurs on Any Day Within the Week

Weekly Tolerance Reliability Daigram

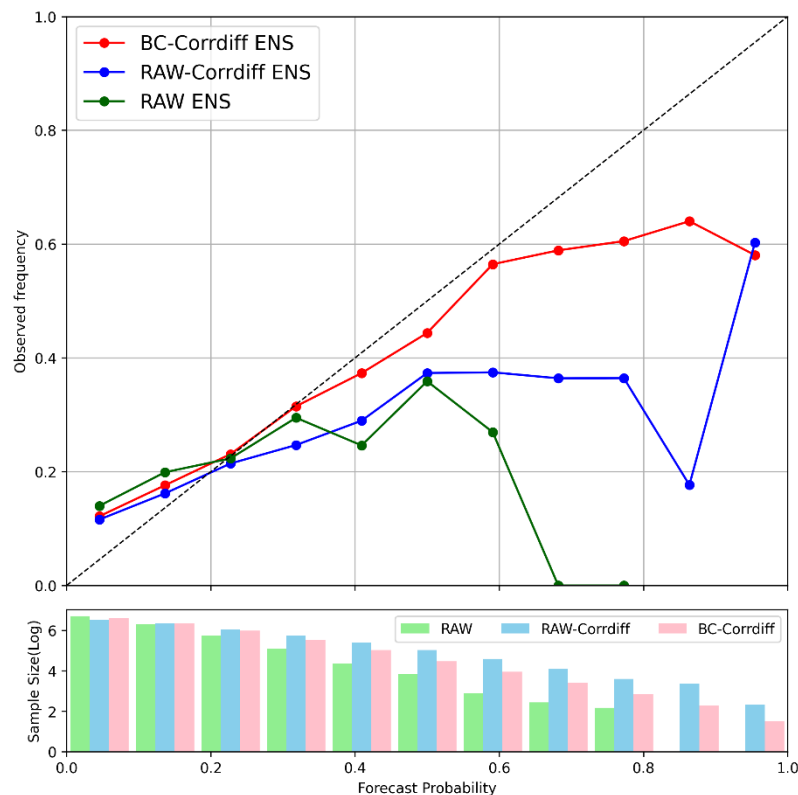
was computed on the temporally tolerant domain, providing both temporal and spatial tolerance

Reliability Diagram

Day15



Weekly Tolerance



1. Temporal-tolerant verification improves forecast reliability and increases the frequency of high-confidence forecasts.
2. The BC forecasts exhibit the highest reliability while also issuing high-confidence forecasts most frequently.

1. 在將 CorrDiff 應用於作業化預報之前，對全球數值天氣預報 (NWP) 進行偏差修正 (Bias correction) 是必要的
2. 一套具時空容差性 (spatiotemporal-tolerant) 的驗證架構，能揭露傳統驗證方法所無法捕捉到的預報能力
3. 對於次季節預報而言，目標並非精準預測極端事件的強度、時間與位置，而是識別在指定的區域與時間窗口內是否有可能發生極端事件。基於此目標所設計的預報產品，能為使用者提供更高的實用價值
4. 未來工作將把全球數值天氣預報的大尺度資訊納入偏差修正架構中，以進一步提升預報技巧



Thank You for Your Attention