應用捲積神經網絡及注意力機制提升第三週降雨預報表現

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資料說明

模式 : NCEP-GEFSv12 Reforecast資料

觀測 : TaiSA 高解析格點降雨

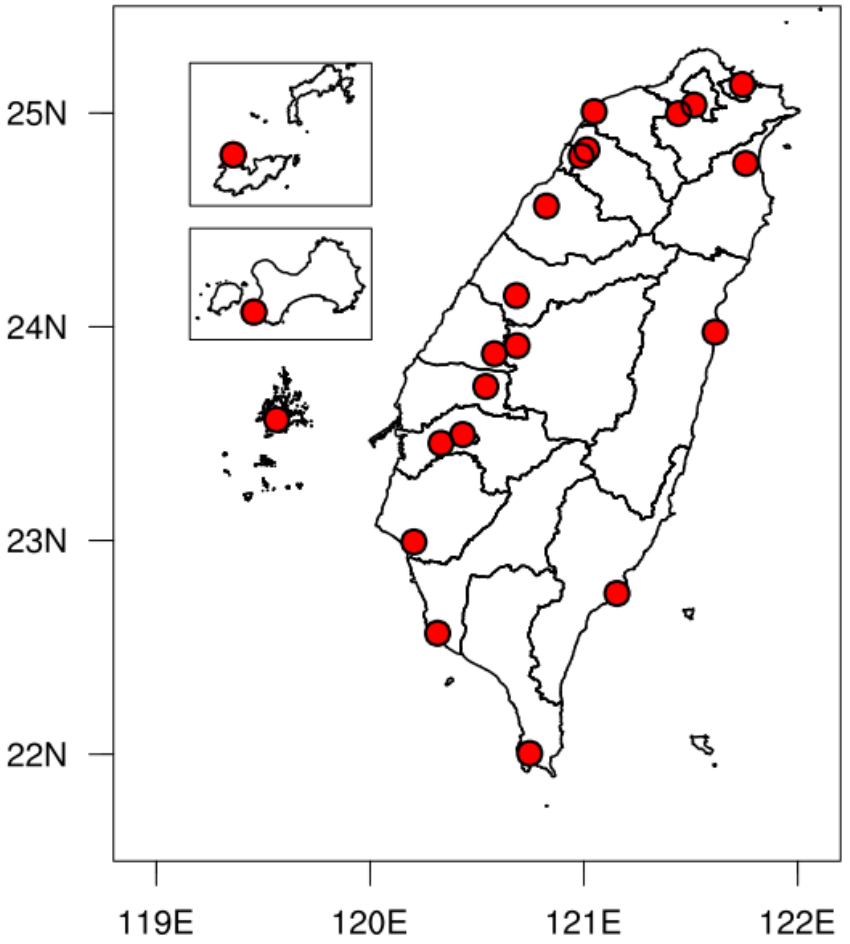
分析年分 : 2000 - 2019

分析月份 : 2,3,4月

校驗時段 : 2000 – 2019 分5等份 Cross Validation
(訓練樣本約為 128筆)

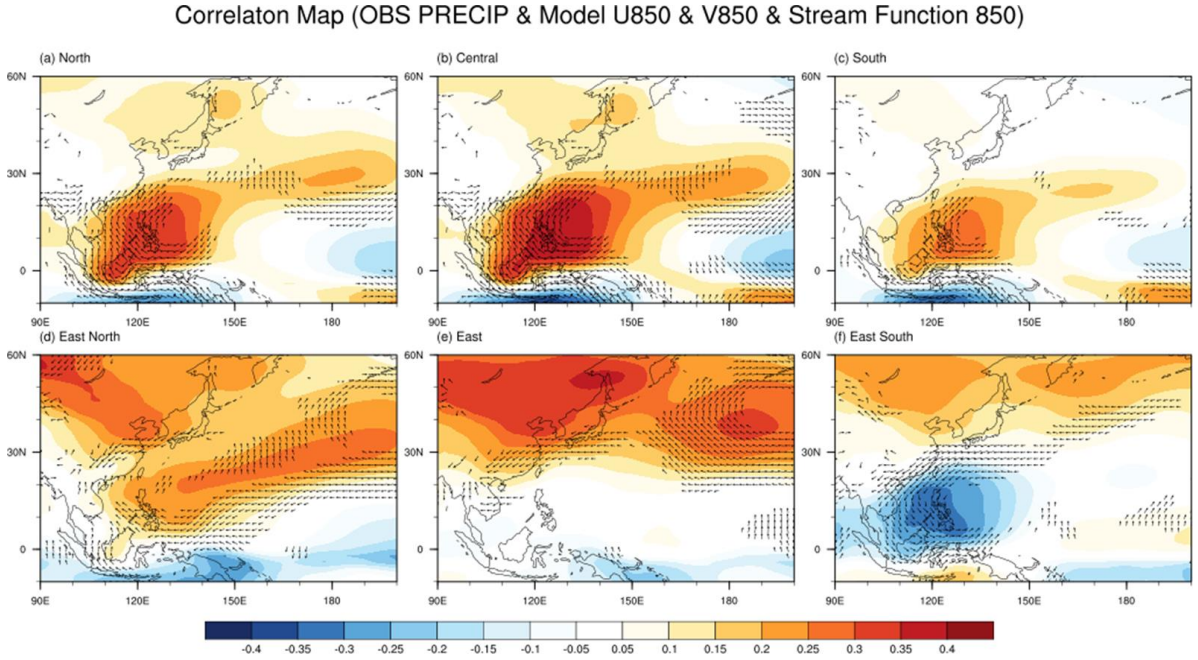
使用變數 : Precip , 850hPa Stream function

預報目標 : 第三週台灣縣市雨量三分類機率預報

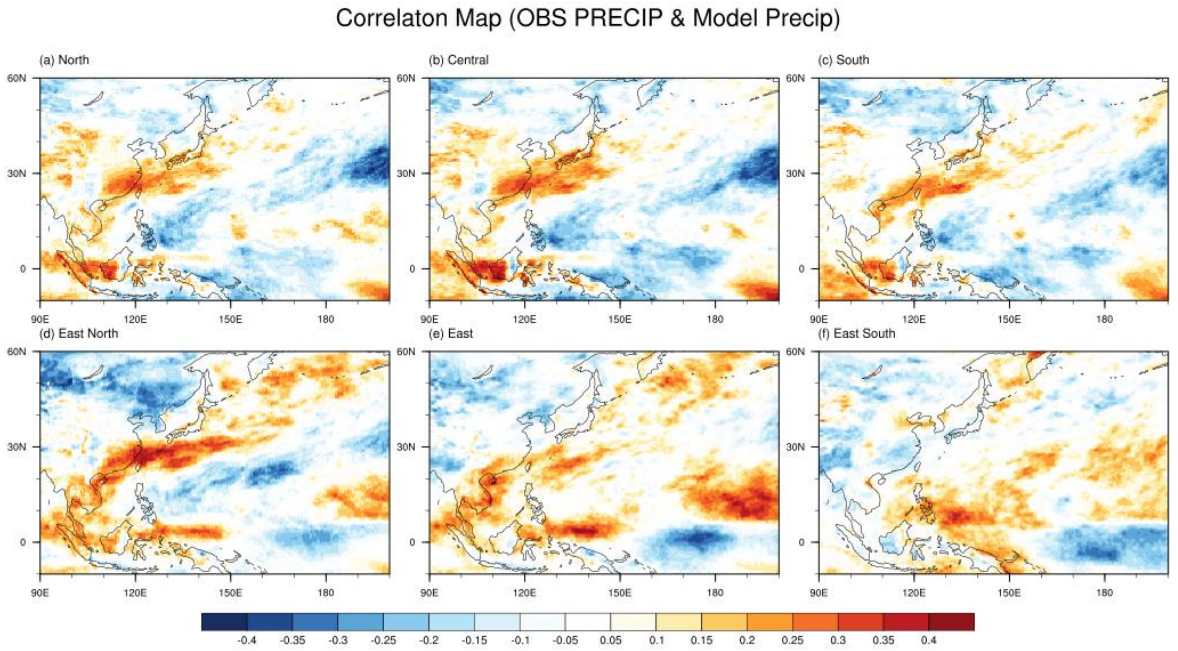


模式預報場(Week3)與觀測降雨相關分析

環流場

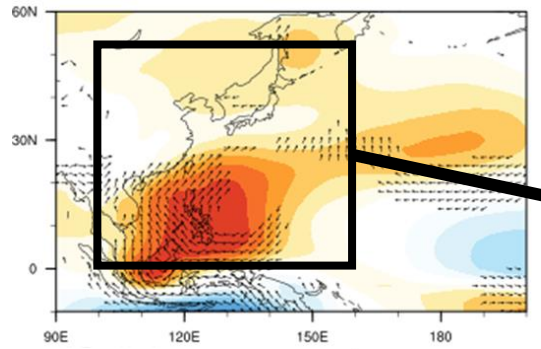


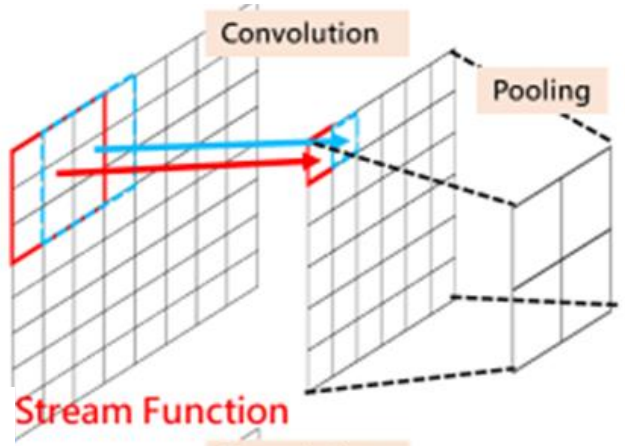
降雨



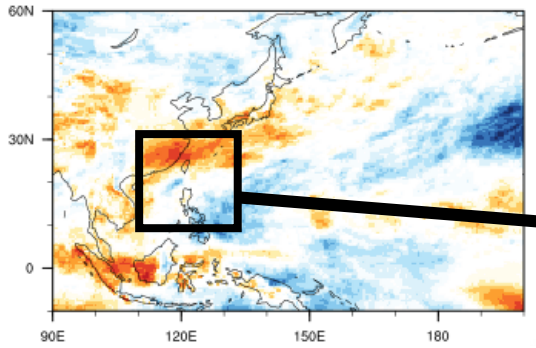
模型架構

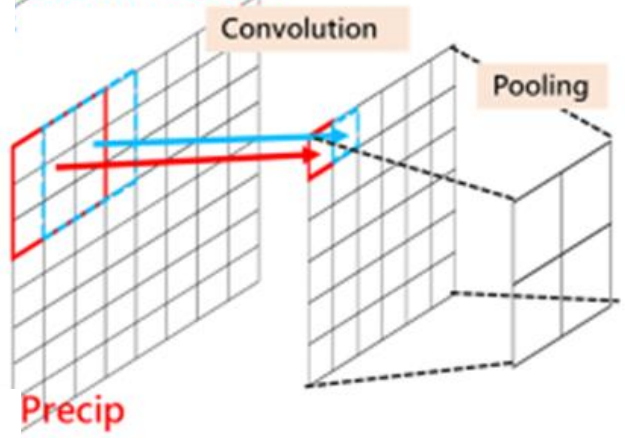
850hPa流函數

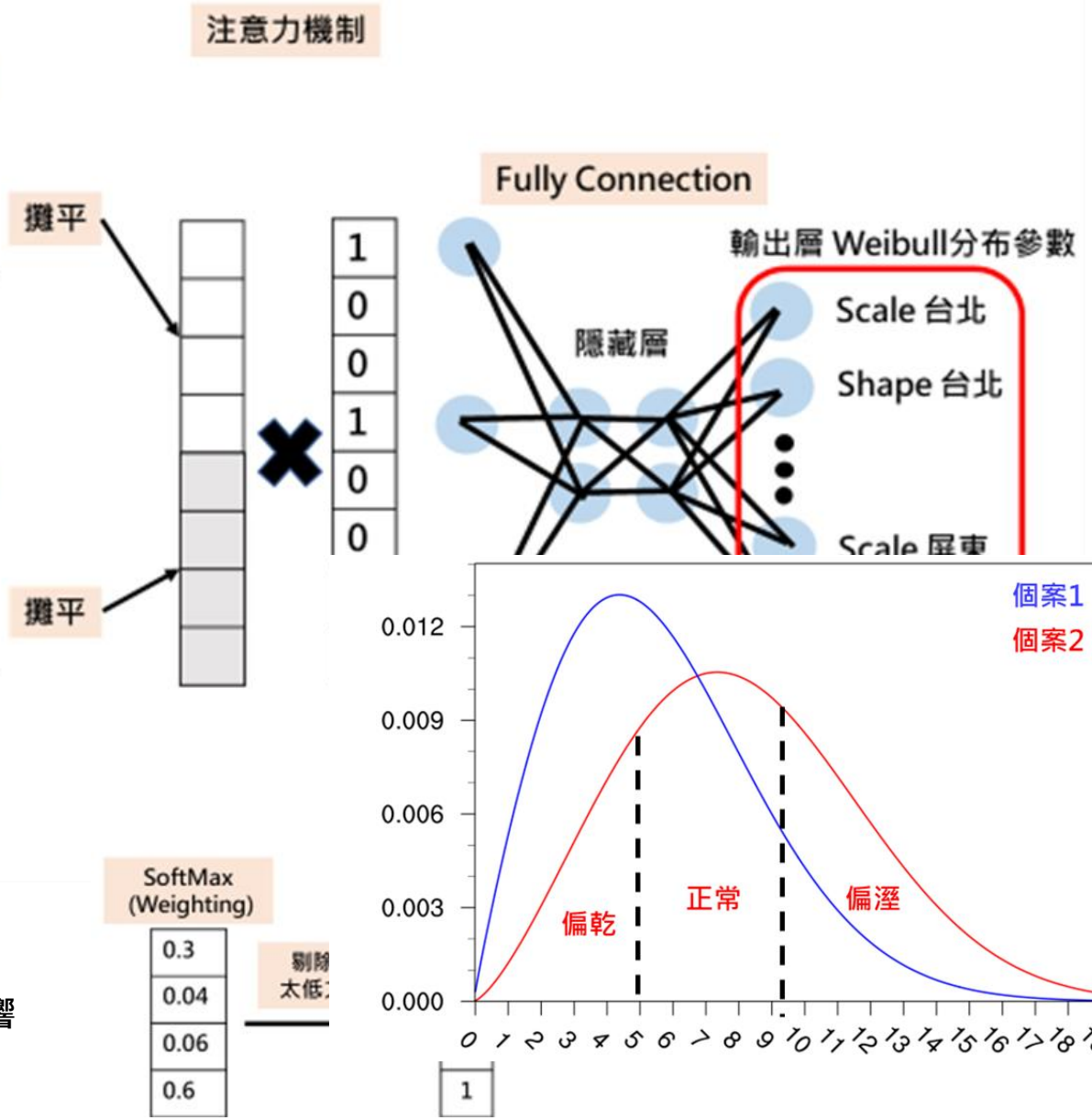




Precip



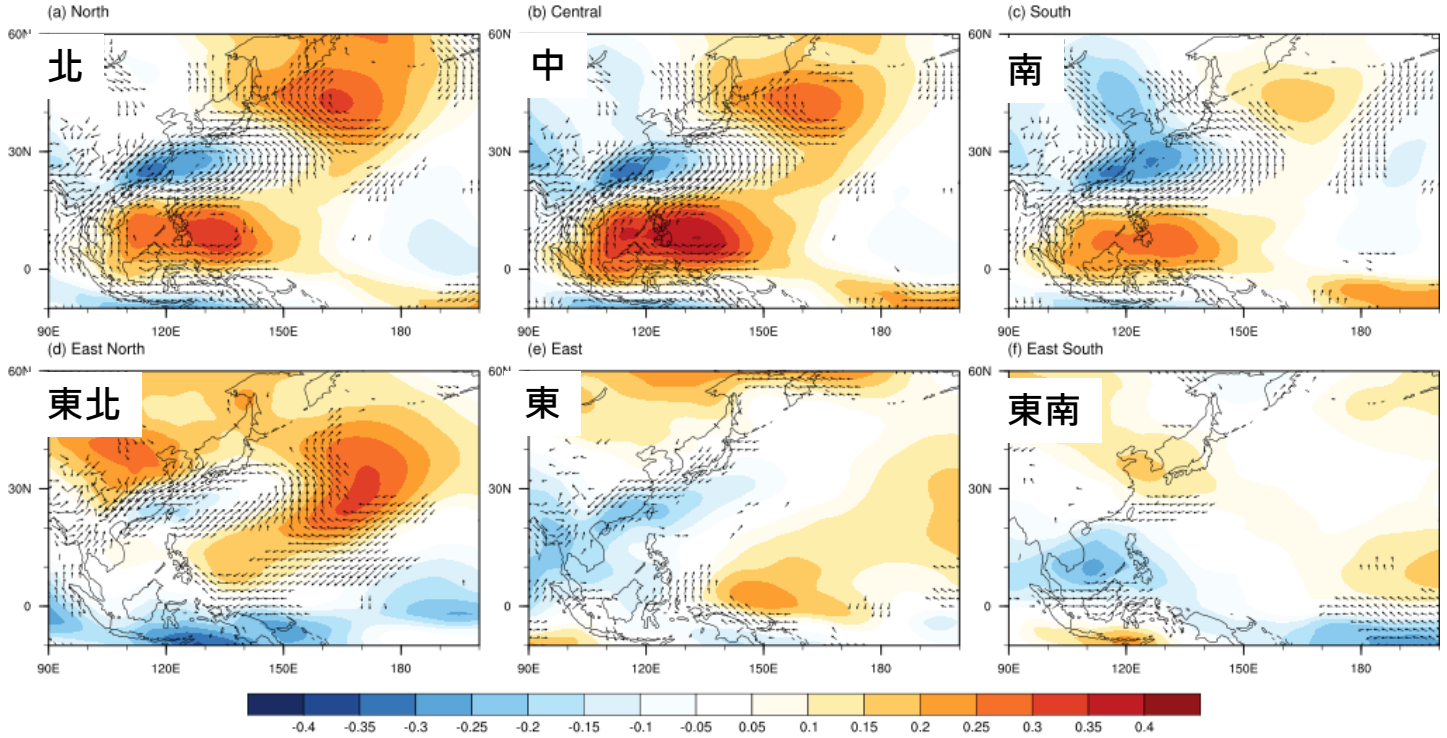




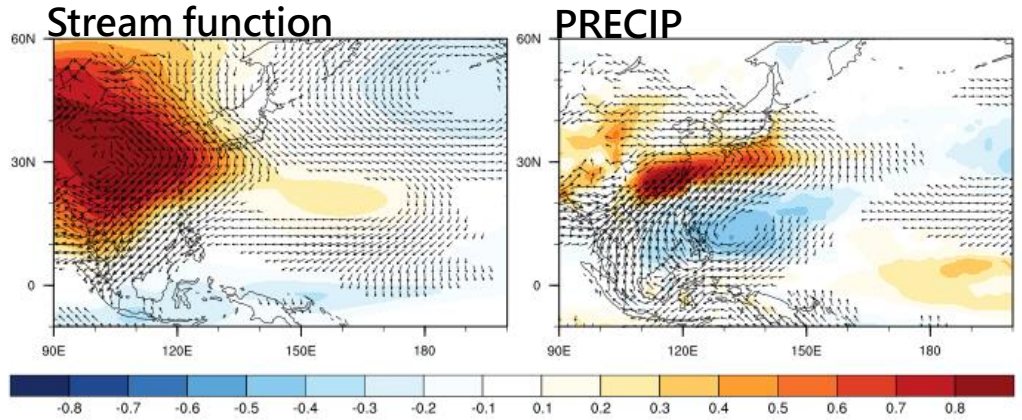
1. 在某些季節，模式預報之降雨訊息至第三週仍具一定程度之參考性
2. 透過加入注意力層，自動篩選模式之環流或降雨特徵作為預報因子
3. 注意力機制不因新增預報因子大量增加估計參數量，減緩overfitting影響
4. 抽取篩選出之特徵

特徵擷取分析

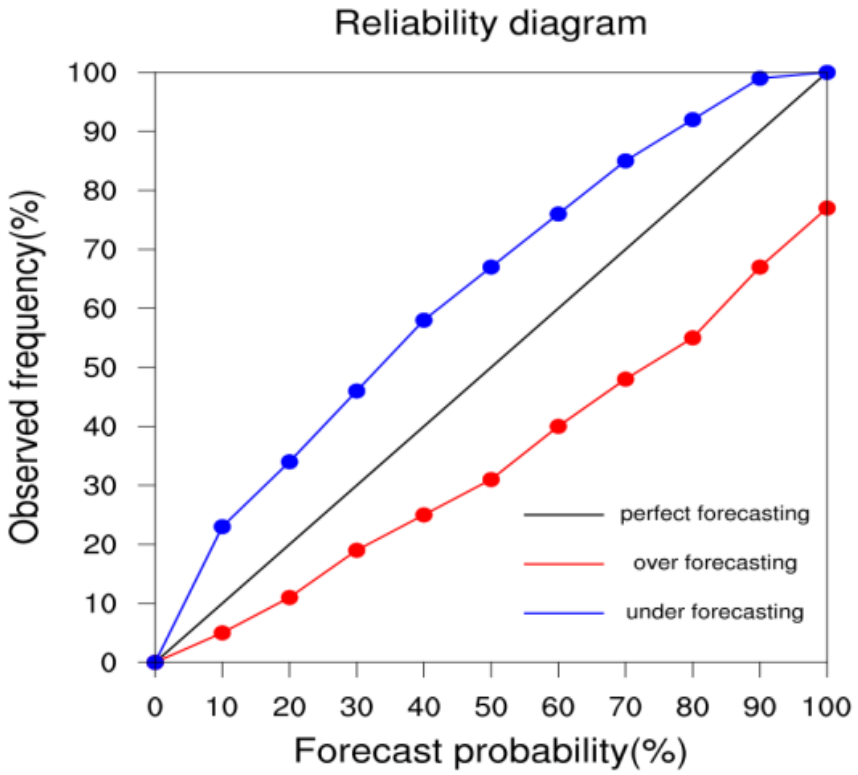
Correlation Map (觀測降雨 與 ERA5 UV850&Stream Function 850)



Correlation Map (擷取之特徵 與 模式 UV850&Stream Function 850&Precip)

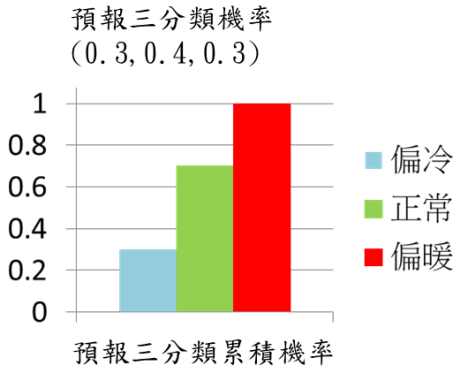


預報校驗方法



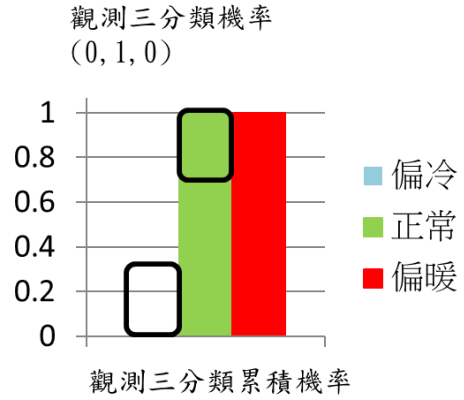
越接近對角線，預報機率越可信

Rank Probability Skill Score (RPSS)



$$RPS = \frac{1}{K-1}\sum_{k=1}^{K}(CDF_{FC,k} - CDF_{OBS,k})^2$$

RPS = 0 完美預報
PRS越大 代表預報得越差

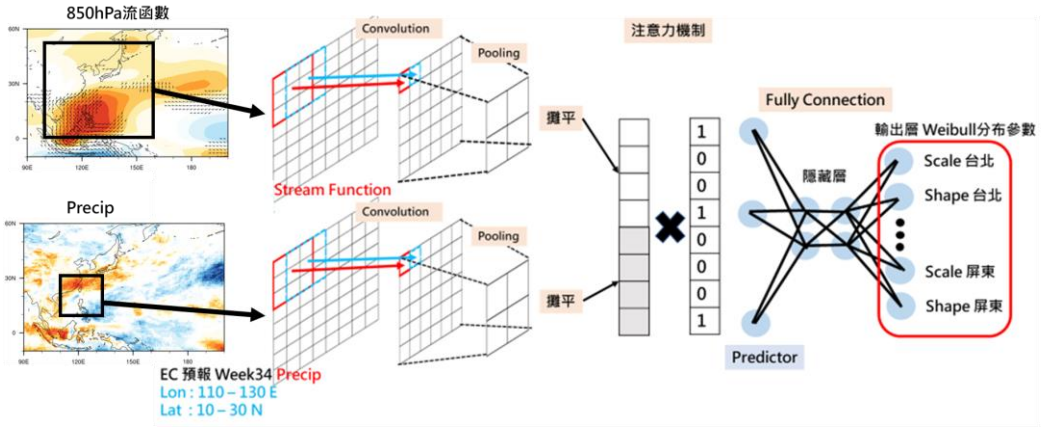


$$RPSS = \frac{\overline{RPS} - \overline{RPS}_{reference}}{0 - \overline{RPS}_{reference}} = 1 - \frac{\overline{RPS}}{\overline{RPS}_{reference}}$$

RPSS = 1 完美預報
> 0 有預報技術
< 0 無預報技術

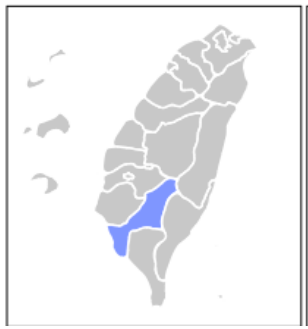
RPSS > 0 代表有預報技術

歷史預報校驗

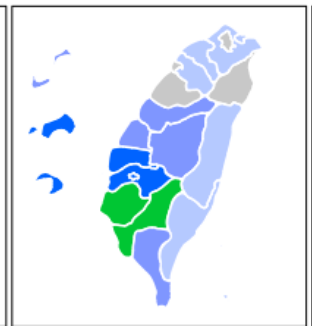


RPSS

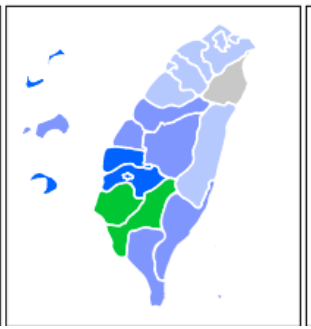
模式原始系集降雨



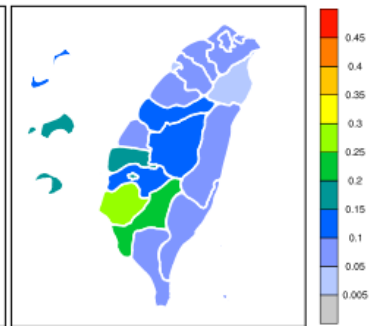
模式降雨校正



CNN-Attention 流函數

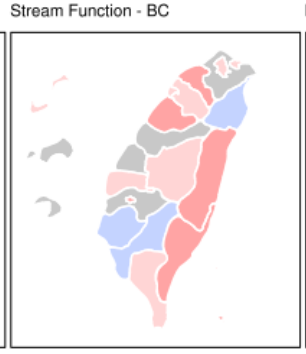


CNN-Attention 多變數

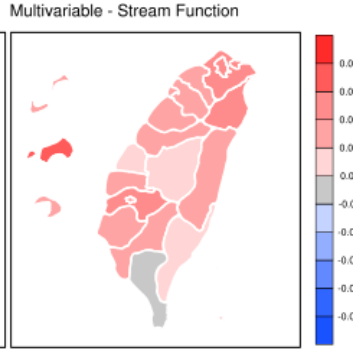


BC - RAW

Stream Function - BC

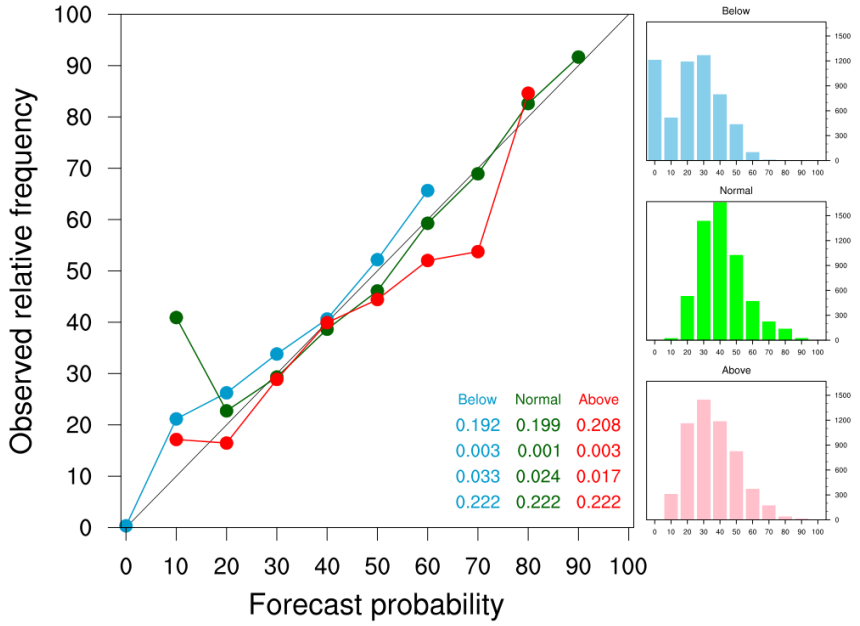


MultiVar - Stream Function



Reliability Diagram

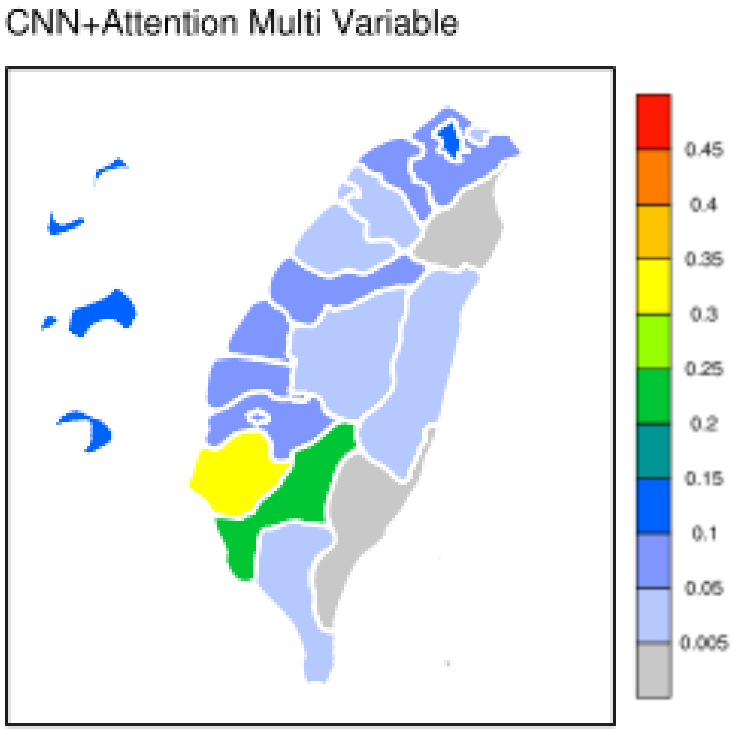
CNN-Attention 多變數



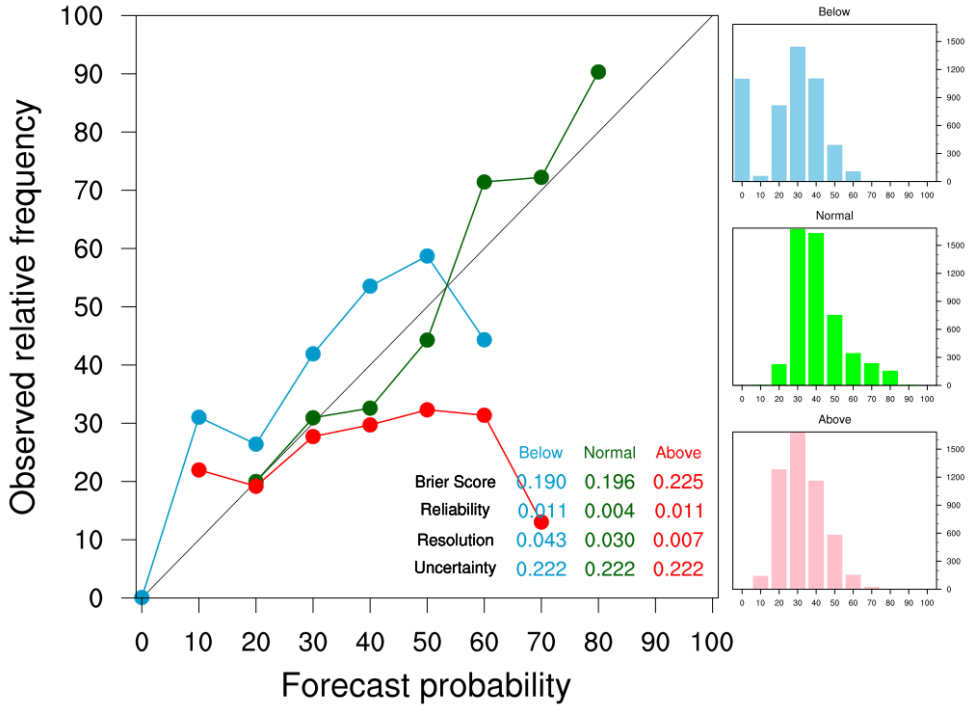
CNN-Attention 多變數 即時預報校驗

2000 – 2019年歷史預報資料建模 → 2022-2024即時預報

RPSS



Reliability Diagram



結論

1. 模式對於鋒面降雨之預報，到第三週仍可參考
2. 注意力機制的加入，可協助篩選重要特徵，降低overfitting影響，提升預報表現
3. 可提供可信且有技術之機率預報
4. 注意力機制有助於分析預報訊號來源，提升使用上的信心

Thanks!