臺灣測站季平均溫度綜合預報雛型與評估

陳苡甄 馮智勇 劉人鳳 陳孟詩

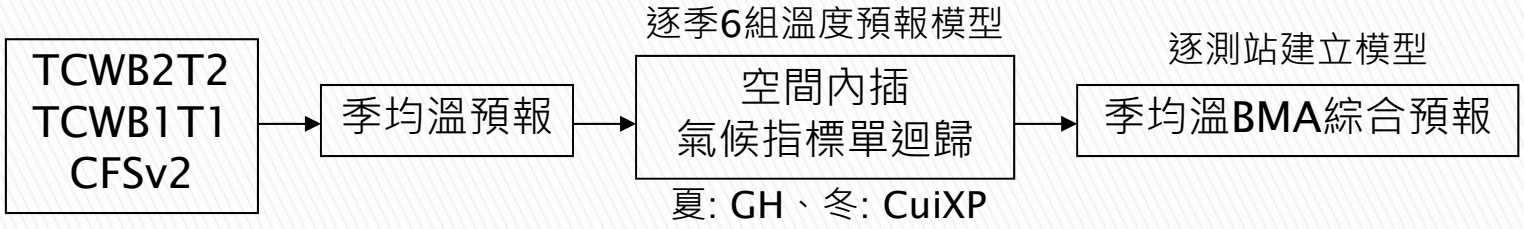
多采公司 Manysplendid Infotech,Ltd.

緣起&大綱

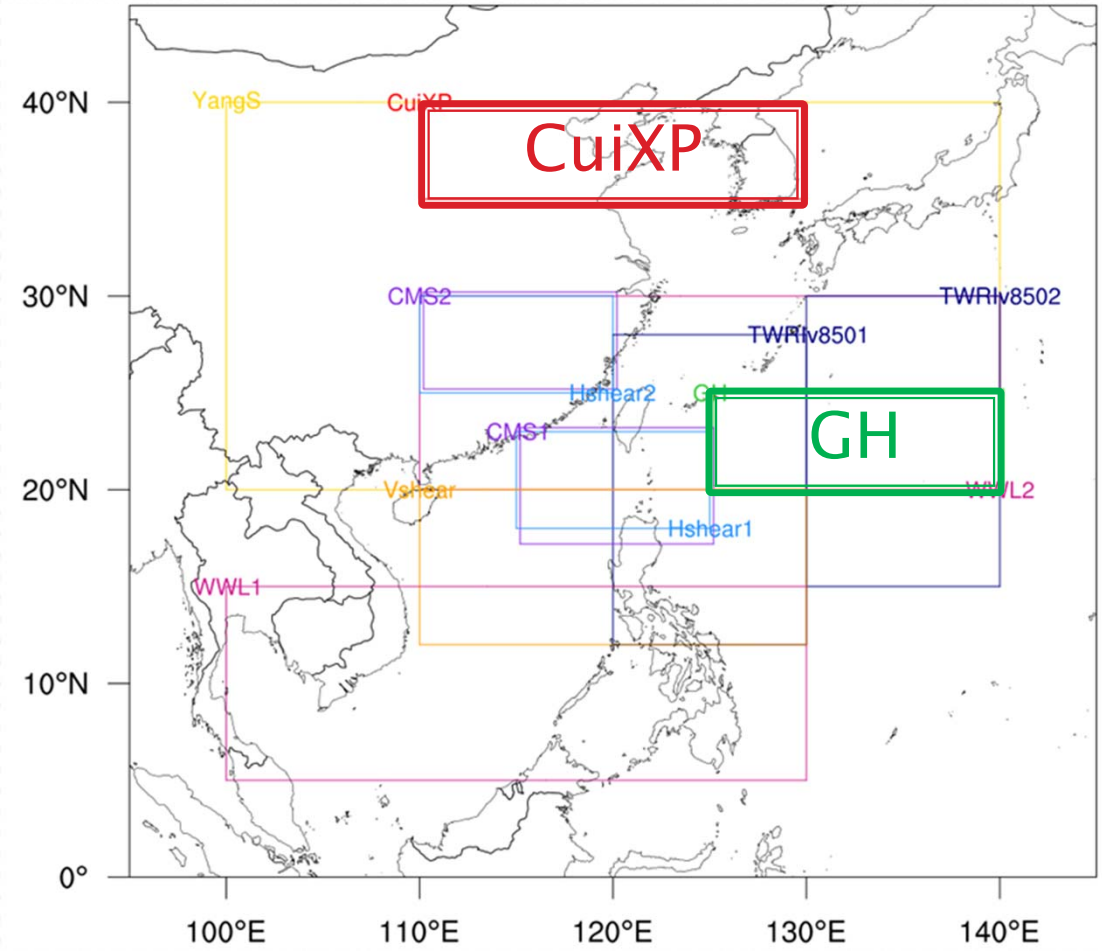
- 發展適用於臺灣地區的短期氣候客觀綜合預報方法，建置整合多模式/多系集預報資訊之測站季平均溫度綜合預報模型
  - 溫度綜合預報流程建置&設計
  - 統計分析預報與觀測值條件機率
  - 溫度綜合預報雛型&初步評估

溫度綜合預報流程建置&設計

流程	臺灣測站	備註
Representative	TCWB2T2, TCWB1T1, CFSv2 三組MME	TCWB2T2: 120 (兩組大氣/兩組海洋交錯搭配) TCWB1T1: 12 (每月固定12天模擬) CFSv2: 20, 24, 28 (每侯模擬四次視月份而異)
Bias Correction	Quantile Mapping	以分析場為校正對象(CFSR)
Downscaling	月: 空間內插、相鄰四點迴歸 季: 空間內插、氣候指標單迴歸	空間內插 (Bilinear) 氣候指標 (夏: GH、冬: CuiXP)
Consensus Forecast	BMA	逐測站建立綜合預報模型

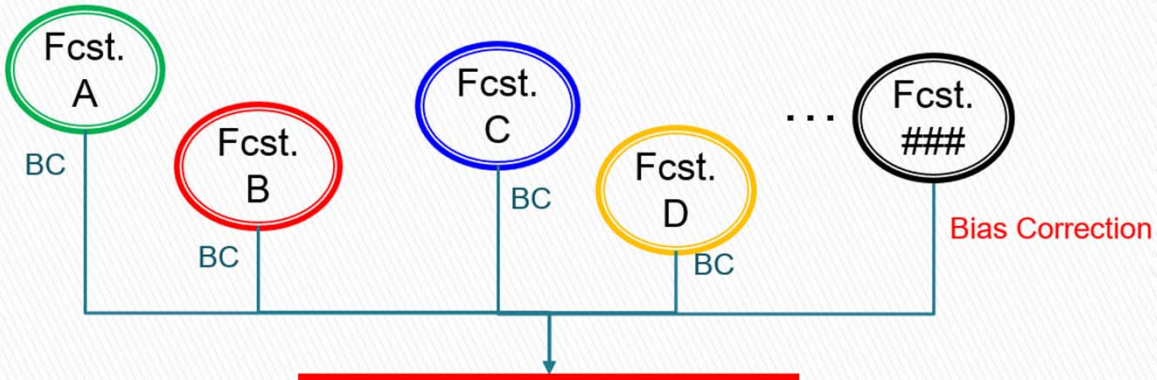


氣候指標範圍示意

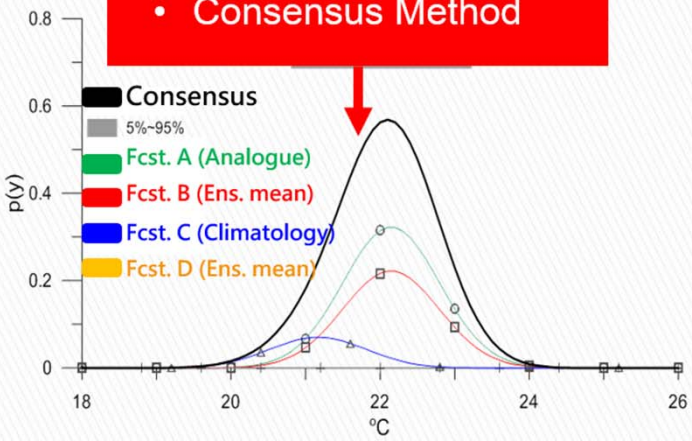

40°N
30°N
20°N
10°N
0°
100°E
110°E
120°E
130°E
140°E
YangS
CuiXP
CMS2
TWRtv8502
TWRtv8501
Hshear2
GH
CMS1
Vshear
WWL2
Hshear1
WWL1

BMA溫度綜合預報方法

- 假設觀測在已知模式預報時的條件機率
  - Raftery et al. (2005)應用於溫度與海平面壓力



- Station Downscaling
- Consensus Method

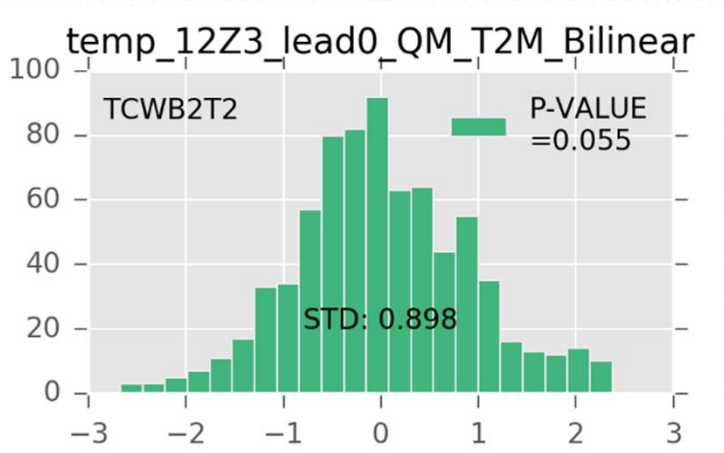


$$f_{BMA}(y \mid x_1, x_2, \ldots, x_k) = \sum_{k=1}^{K} f_k(y \mid x_k) \cdot \omega_k$$

$$= \sum_{k=1}^{K} g\left(y \mid x_k, \sigma^2\right) \cdot \omega_k$$

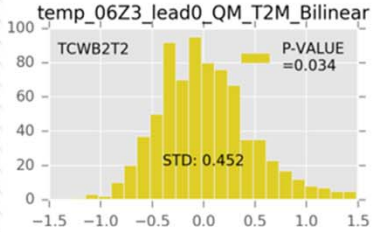
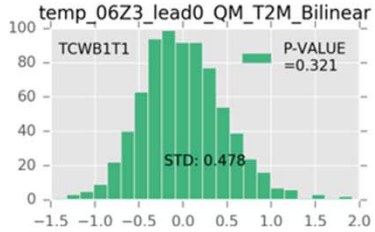
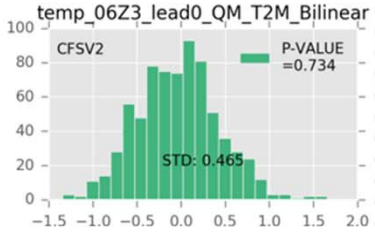
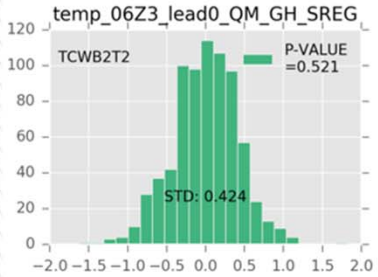
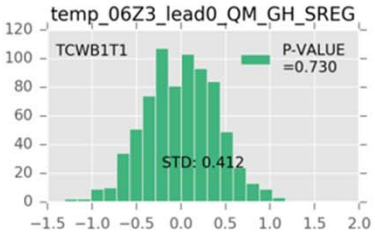
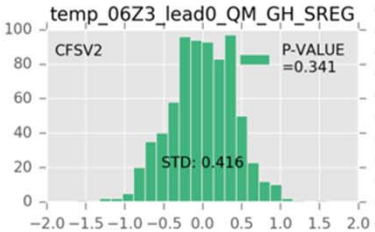
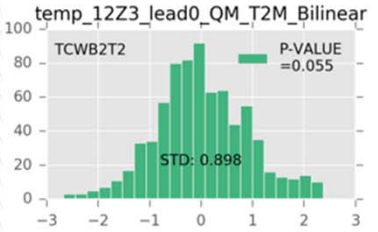
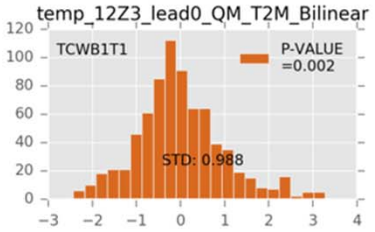
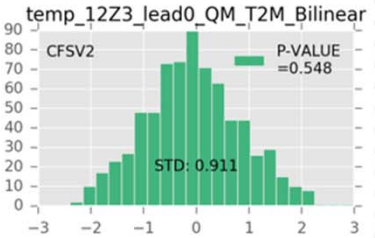
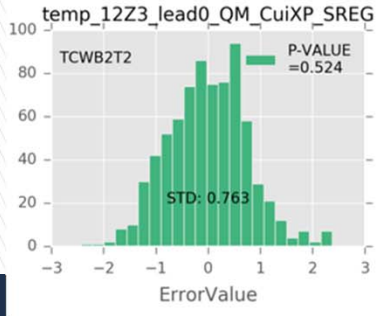
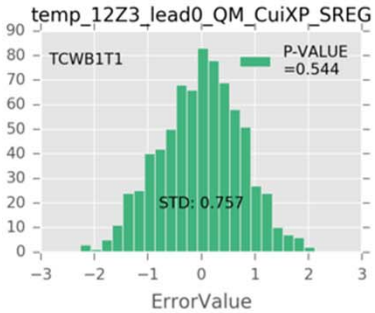
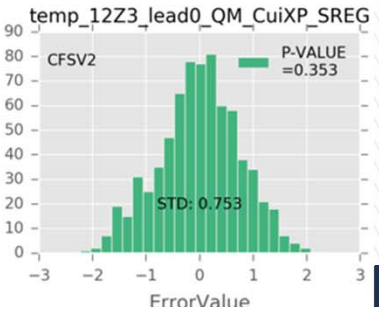
統計分析預報與觀測值條件機率

- Kolmogorov-Smirnov Test
  - H0: 樣本群符合理論分布
  - 常態分布→μ、σ
  - α=0.05



- 作法
  - 單一模式/季節/降尺度模型的所有測站/年份進行條件機率檢定，將每次預報對應觀測計算差值(差值=觀測-預報)，將差值累計次數繪製成直方圖，透過K-S檢定該樣本群是否滿足常態分佈假設

測站降尺度預報條件機率檢定結果

	TCWB2T2	TCWB1T1	CFSv2
JJA			
Bilinear			
GH			
DJF			
Bilinear			
CuiXP			

溫度綜合預報雛型&初步評估

溫度綜合預報模型建置說明

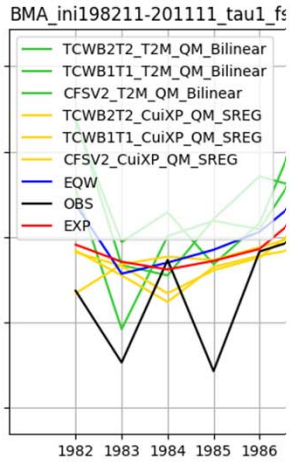
流程	臺灣測站
Representative	TCWB2T2, TCWB1T1, CFSv2 三組MME
Bias Correction	Quantile Mapping
Downscaling	月: 空間內插、相鄰四點迴歸 季: 空間內插、氣候指標單迴歸
Consensus Forecast	BMA

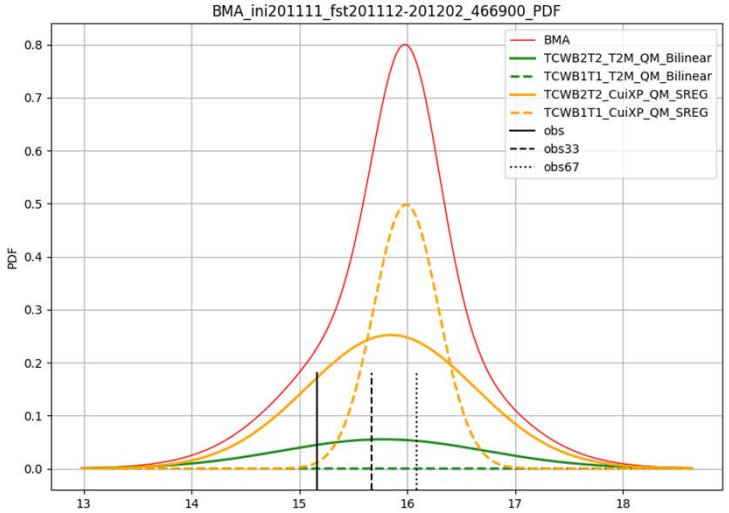
- Org
  - 採遮蔽預報年以溫度值進行偏差校正、測站降尺度以及綜合預報
- Ano
  - 採遮蔽預報年將溫度值扣除訓練期的氣候場得到距平值，再進行QM、DS、BMA
  - 將預報距平序列疊加測站氣候值而為新預報
- 評估對象: EQW v.s. EXP

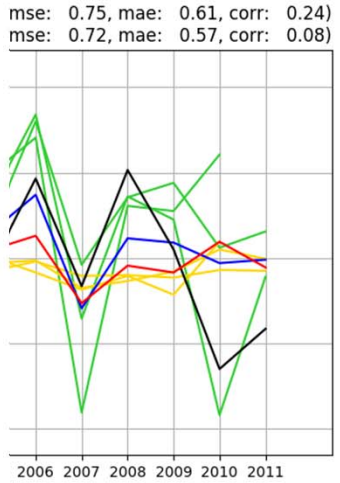
冬季溫度綜合預報初步評估

以原值建模溫度綜合預報時序圖

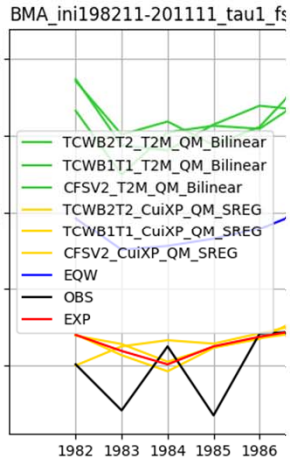
板橋

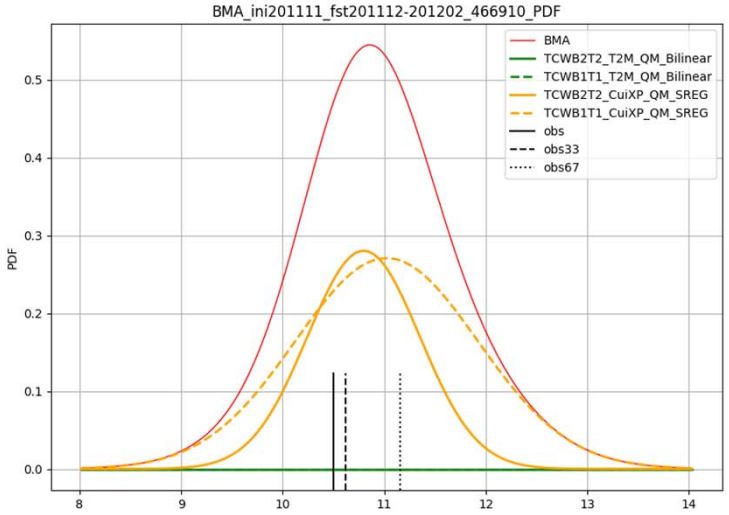


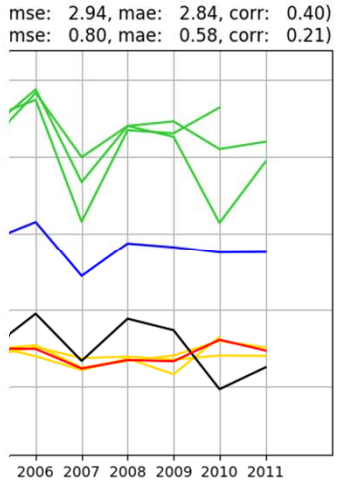




鞍部

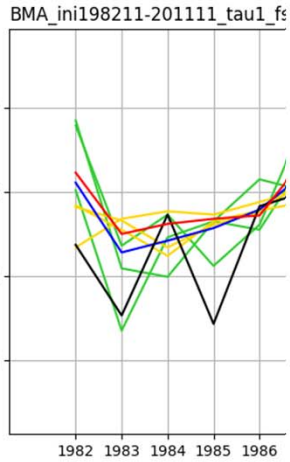


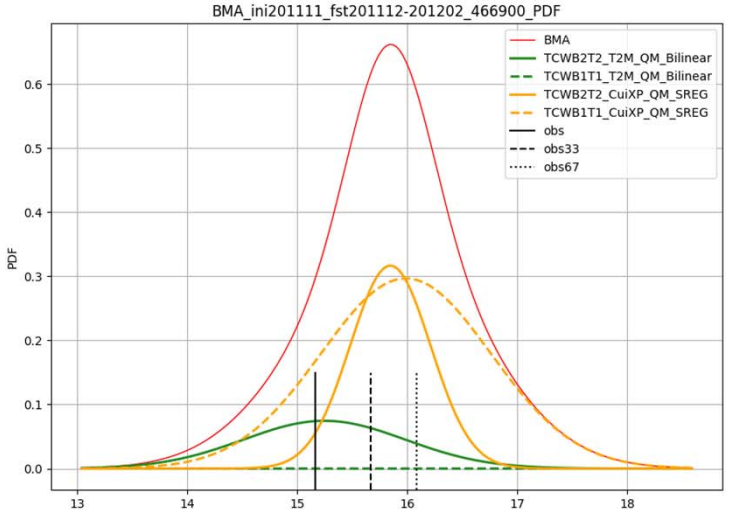


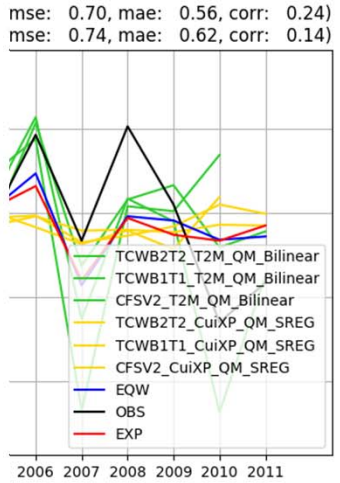


距平值建模溫度綜合預報時序圖

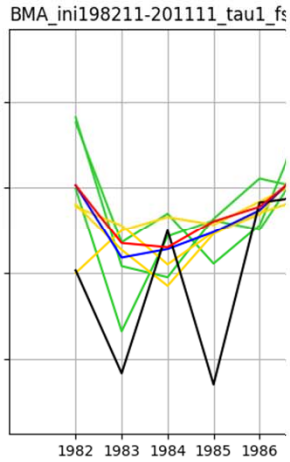
板橋

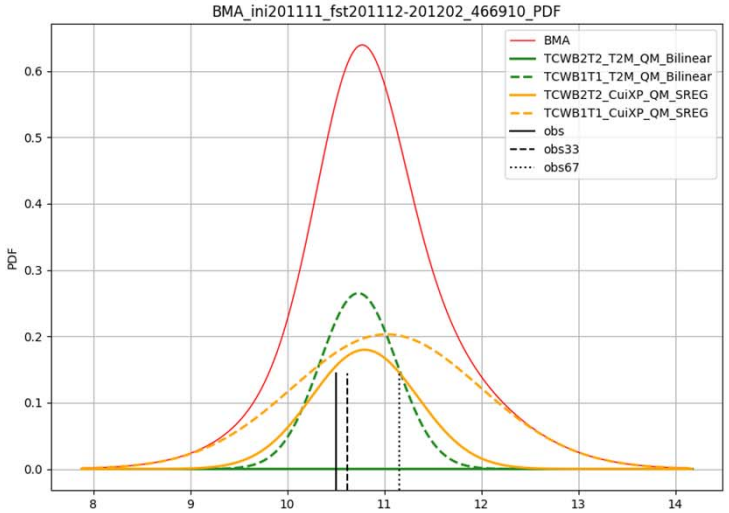


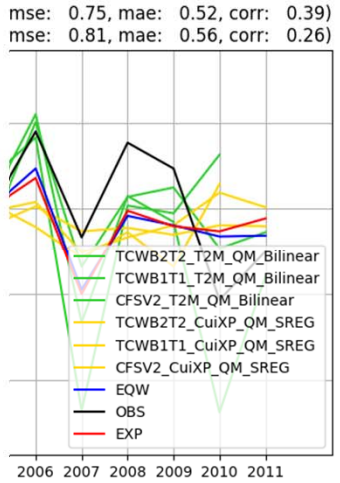




鞍部





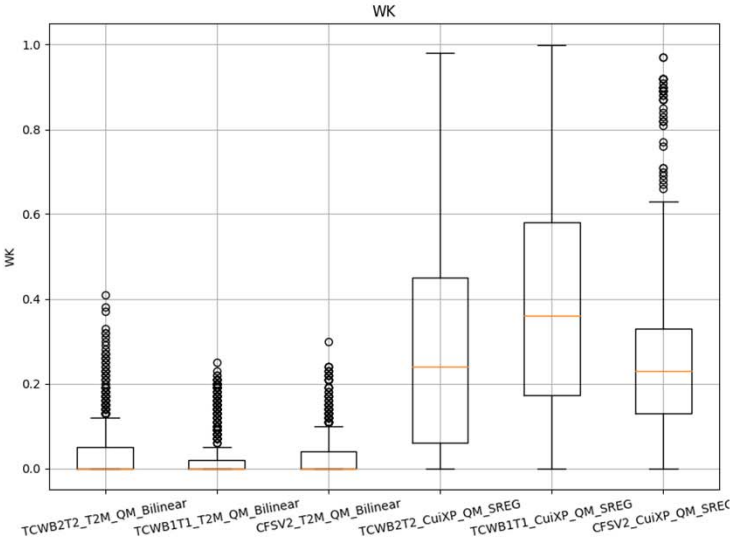


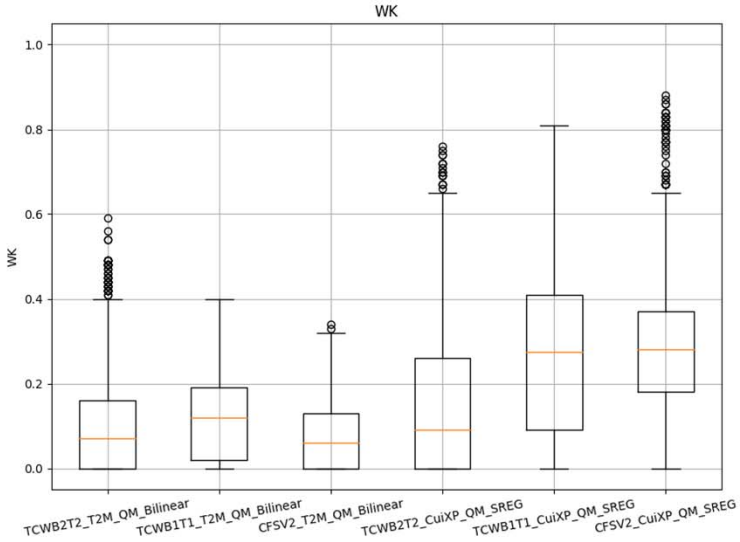
統計分析BMA權重係數&標準差

Org

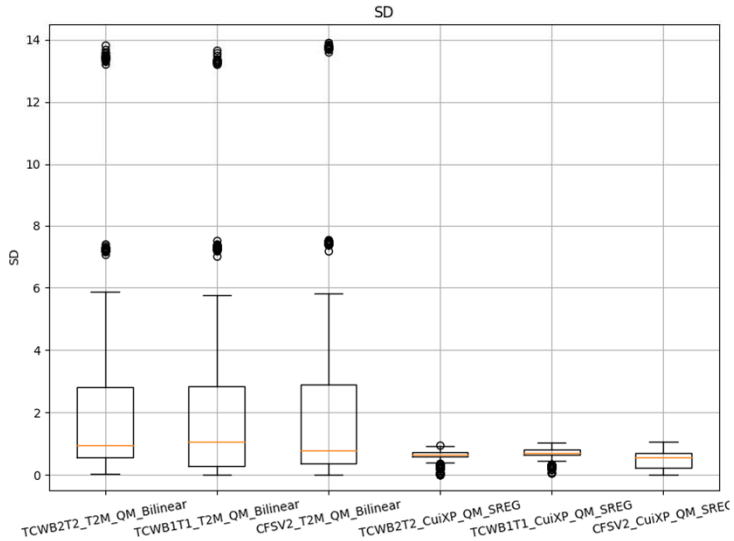
Ano

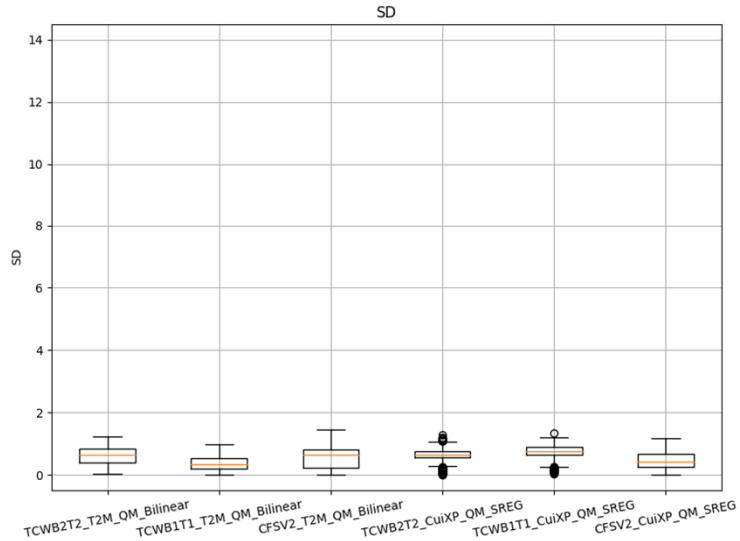
WK





SD



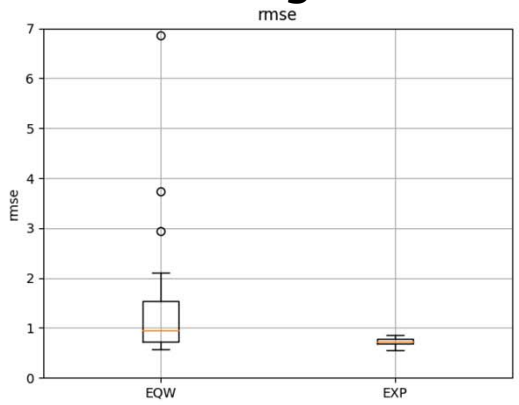


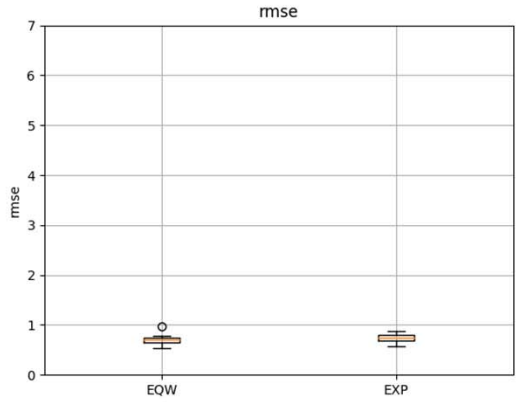
溫度綜合預報-定量校驗

Org

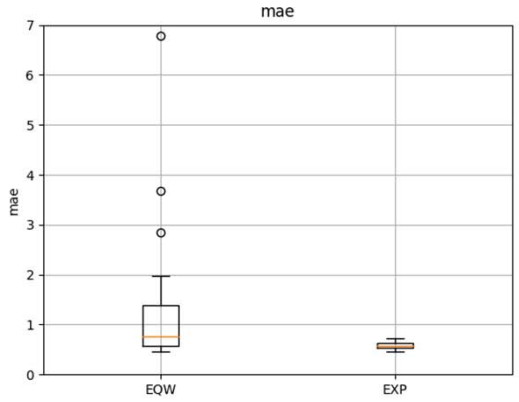
Ano

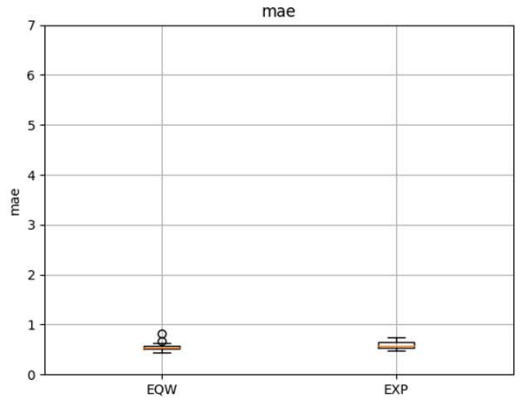
RMSE



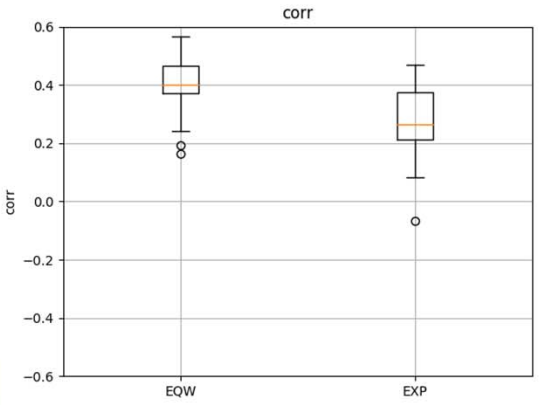


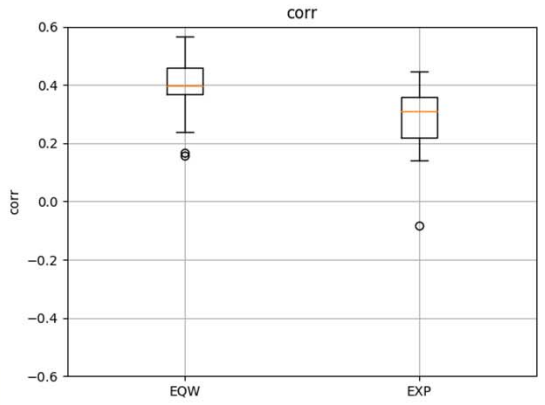
MAE





CORR



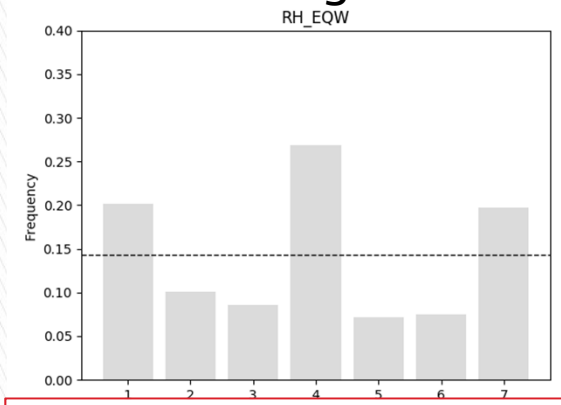


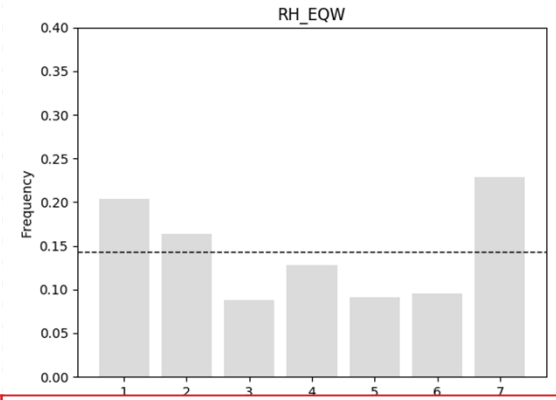
溫度綜合預報–機率校驗

Org

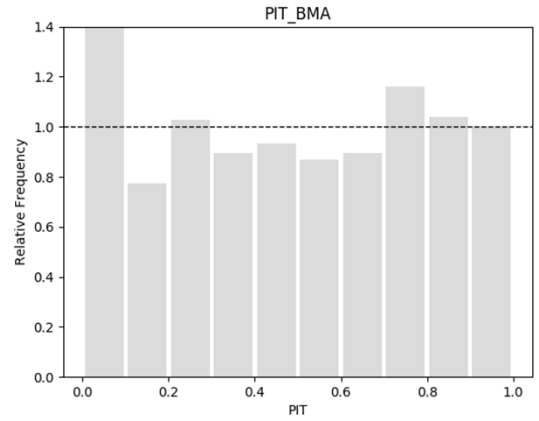
Ano

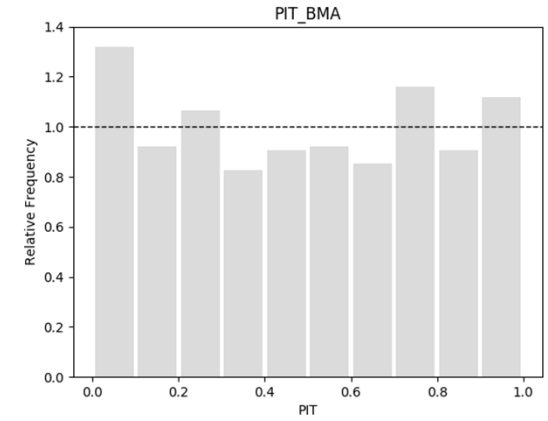
RH_EQW



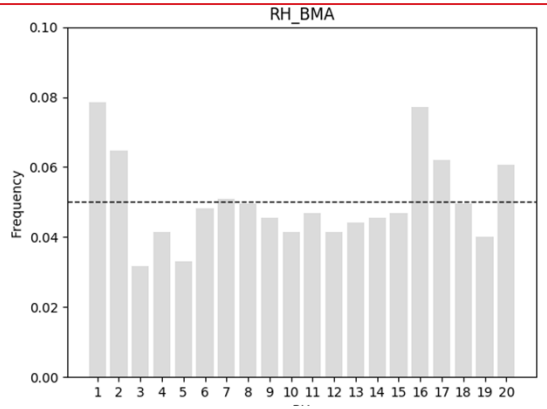


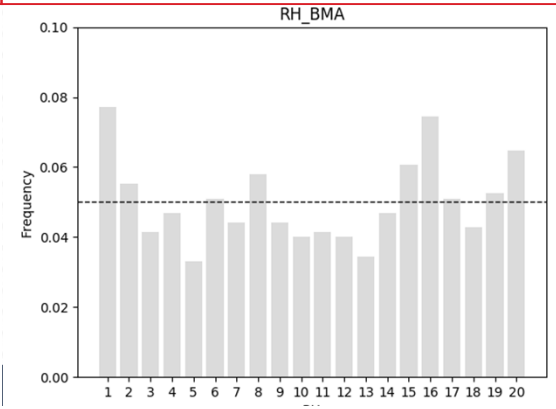
PIT_BMA





RH_BMA



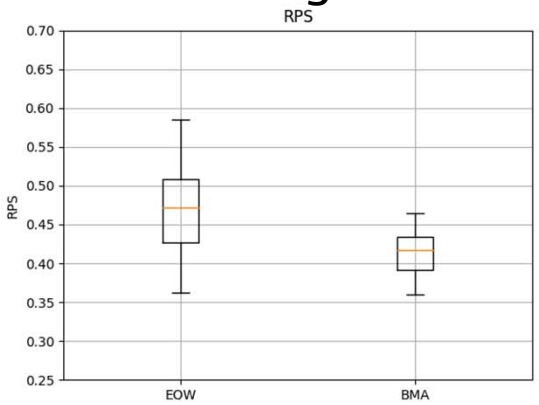


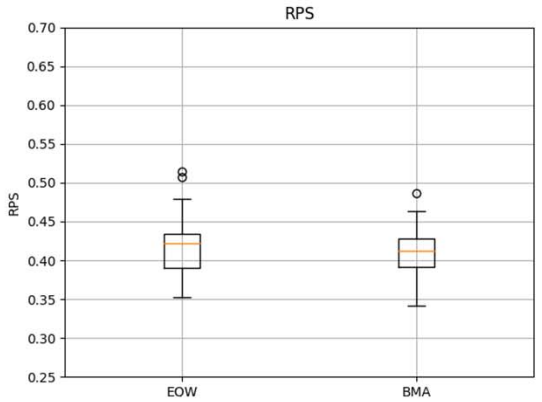
溫度綜合預報-三分類預報

Org

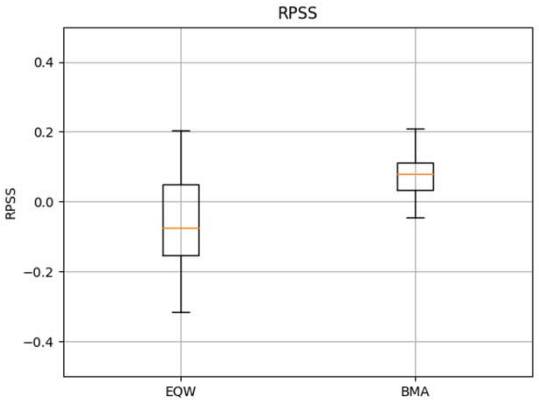
Ano

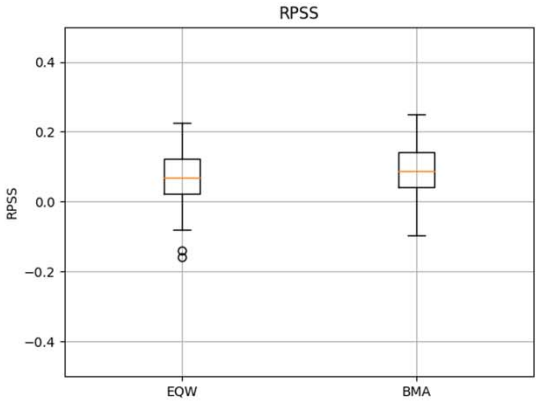
RPS=0最佳



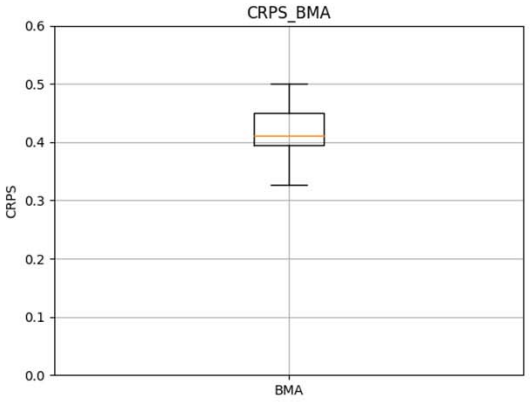


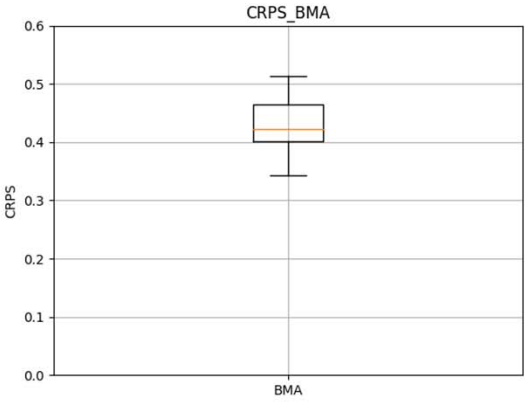
RPSS=1最佳





CRPS=0最佳

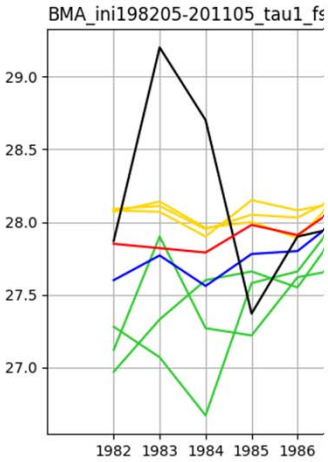


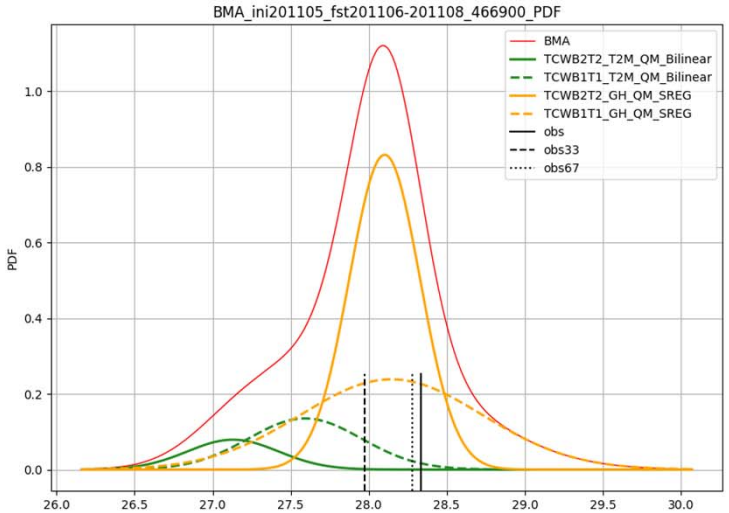


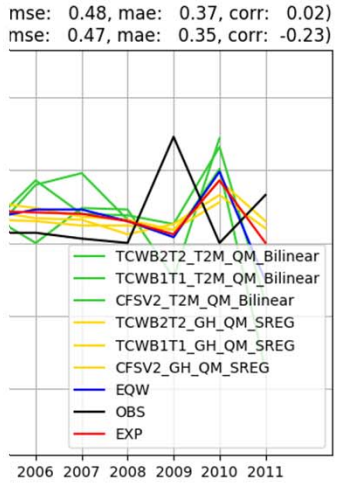
夏季溫度綜合預報初步評估

以原值建模溫度綜合預報時序圖

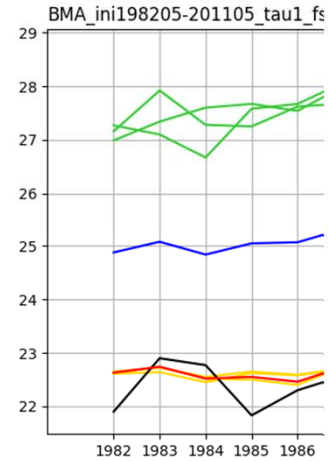
板橋

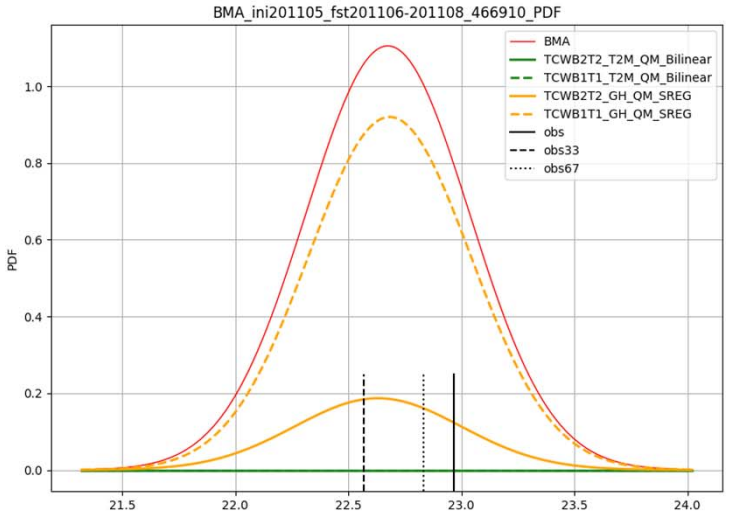


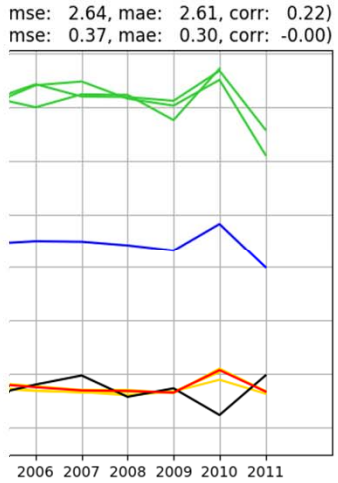




鞍部

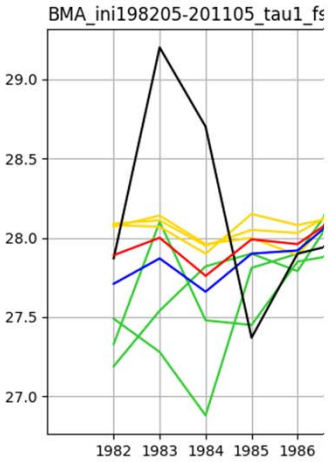


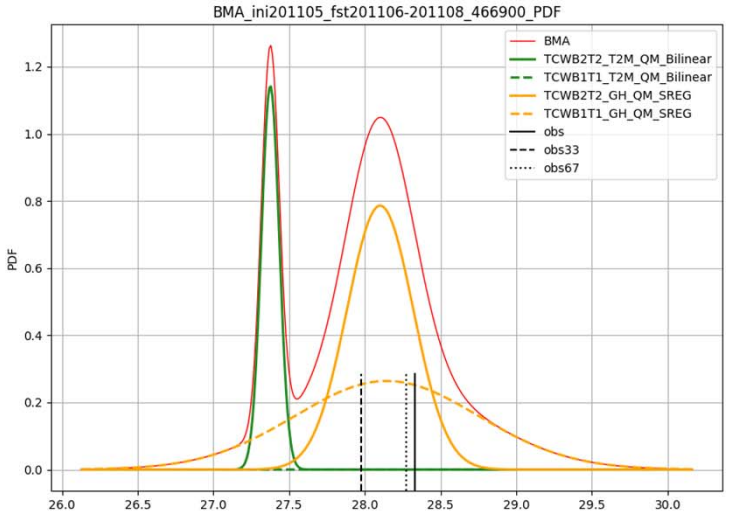


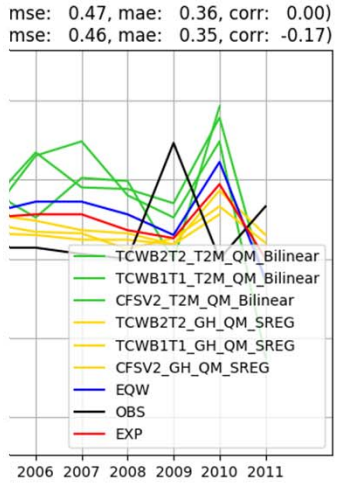


距平值建模溫度綜合預報時序圖

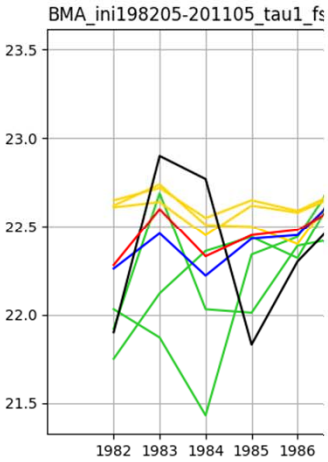
板橋

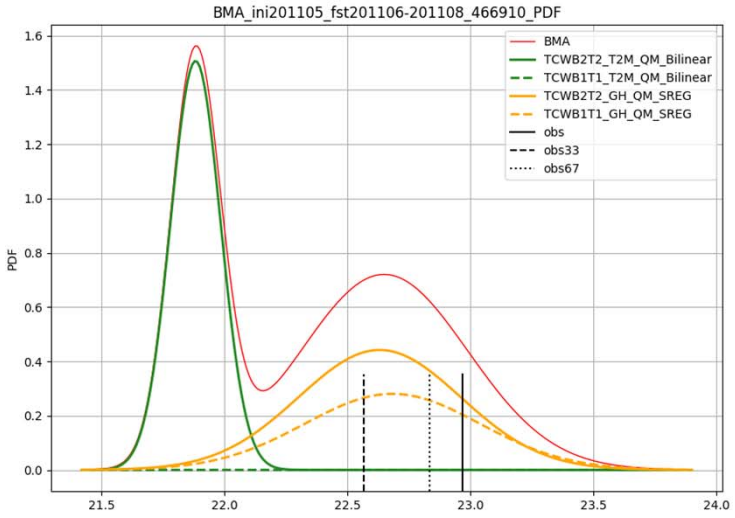


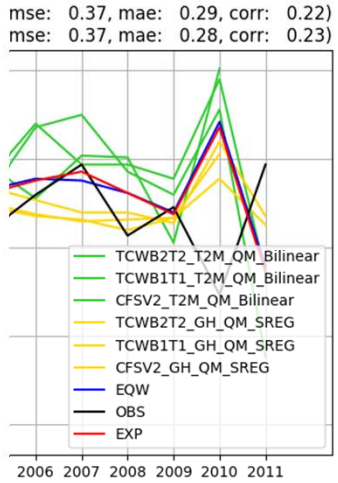




鞍部





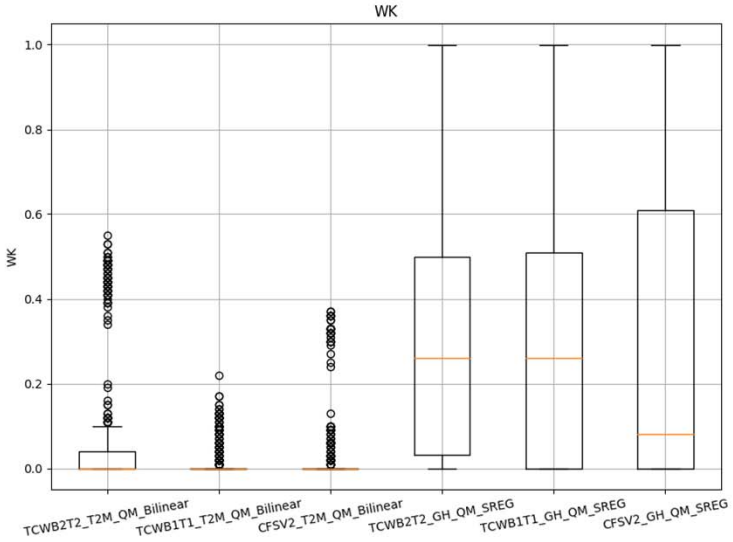


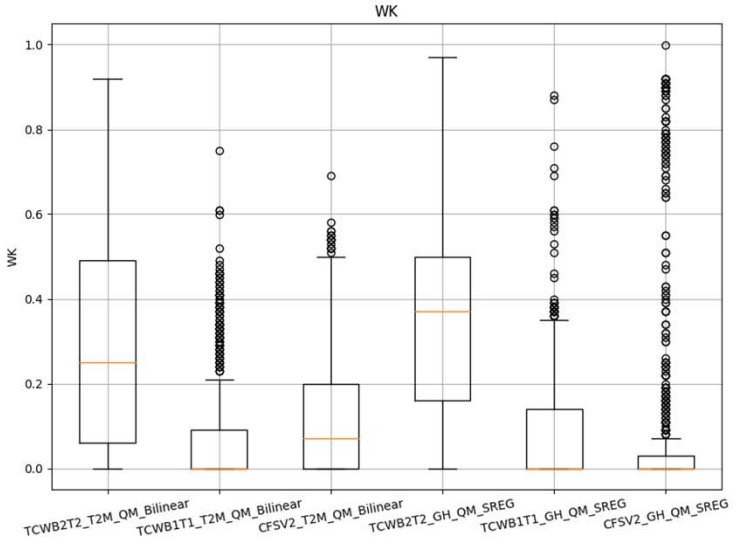
統計分析BMA權重係數&標準差

Org

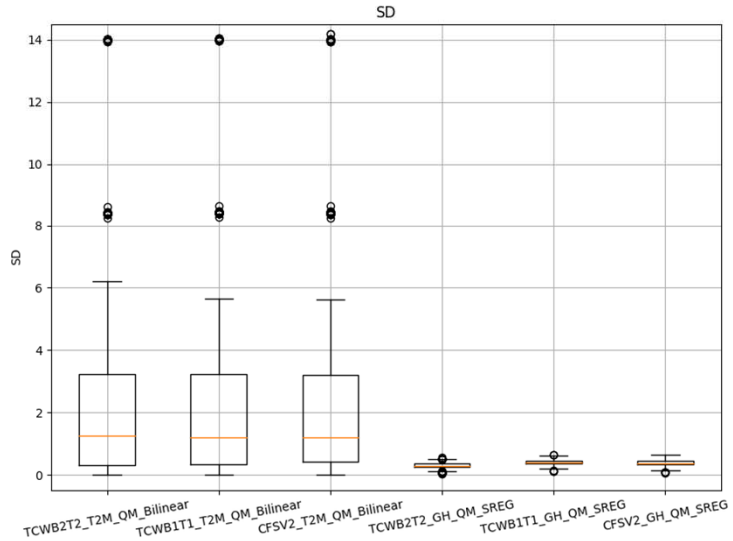
Ano

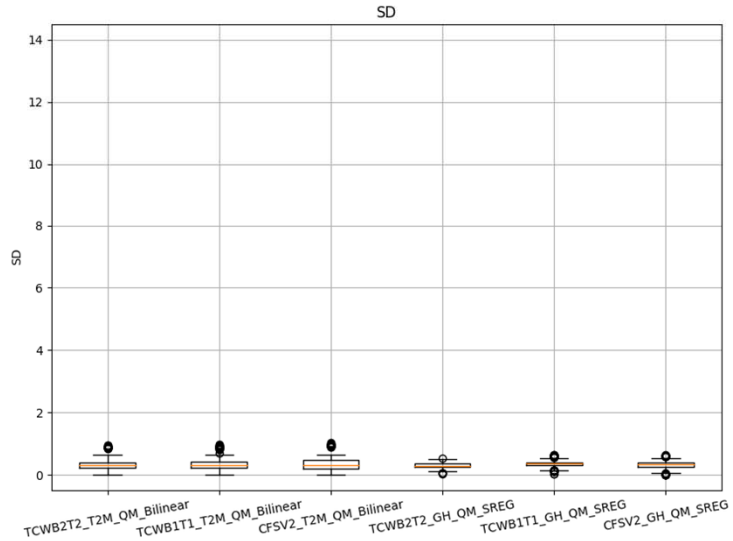
WK





SD



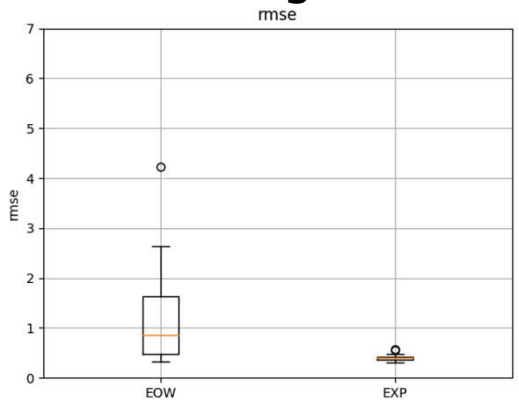


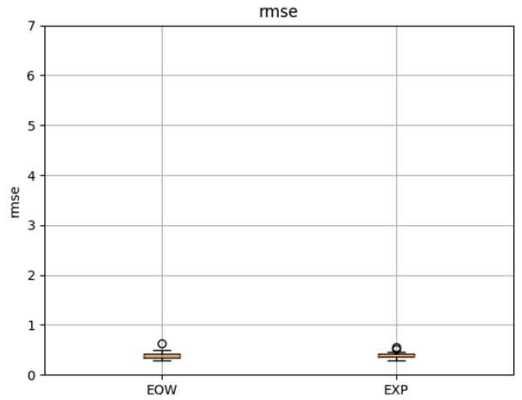
溫度綜合預報-定量校驗

Org

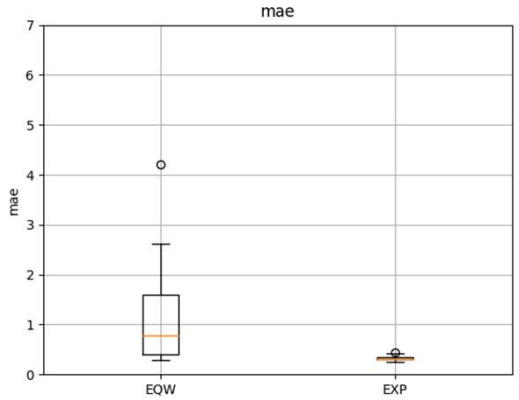
Ano

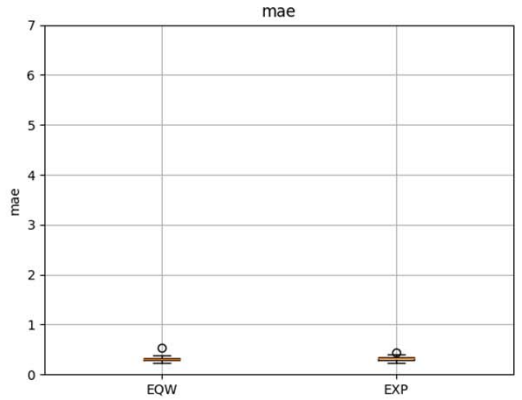
RMSE



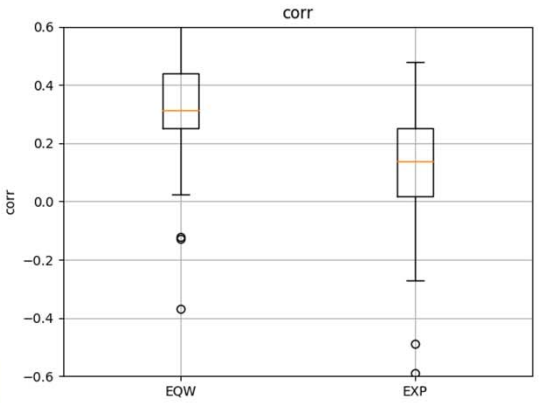


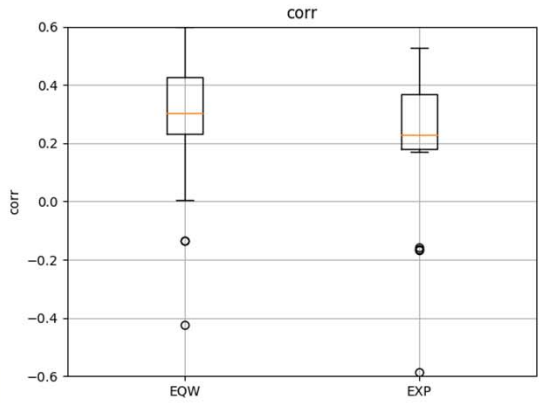
MAE





CORR



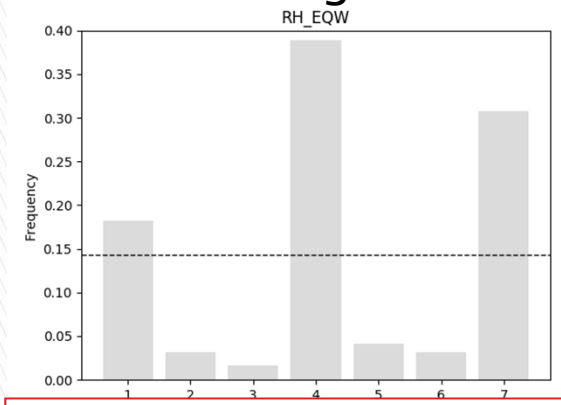


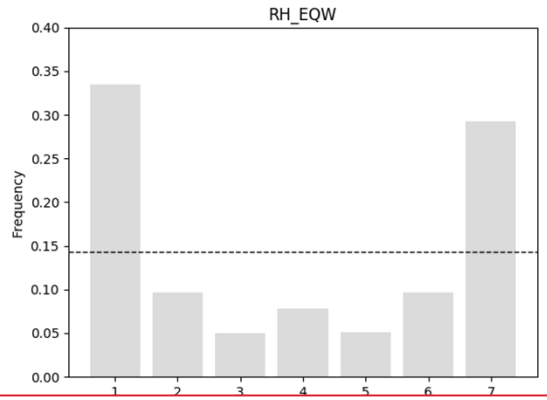
溫度綜合預報–機率校驗

Org

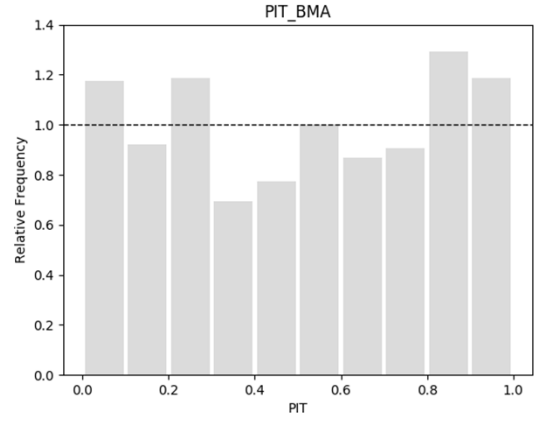
Ano

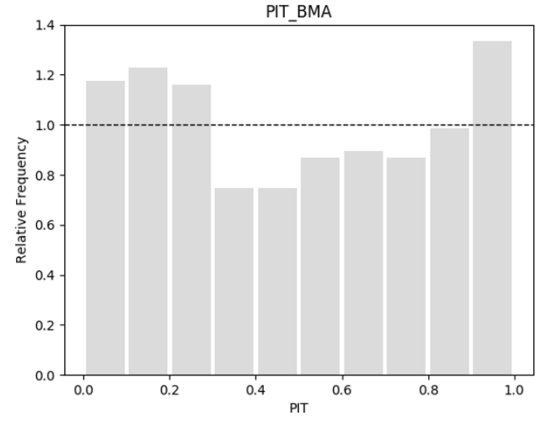
RH_EQW



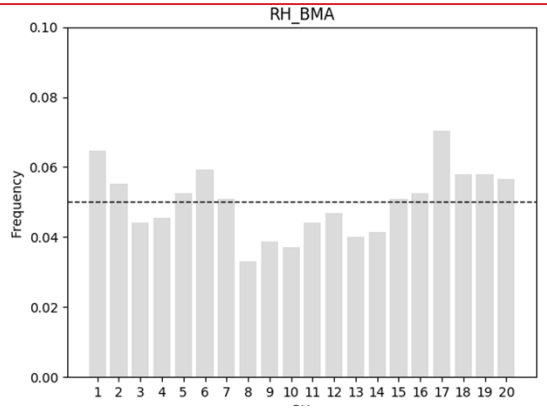


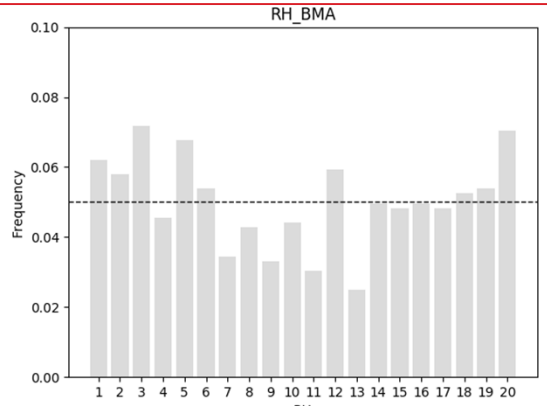
PIT_BMA





RH_BMA



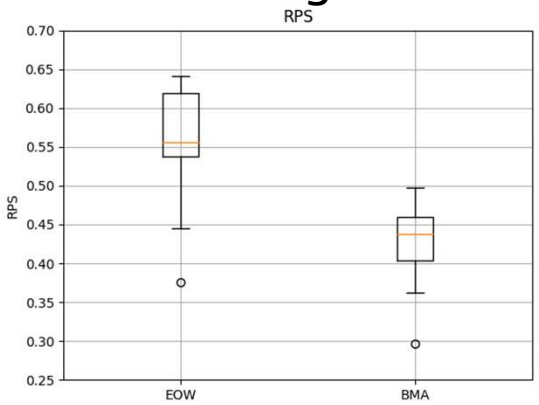


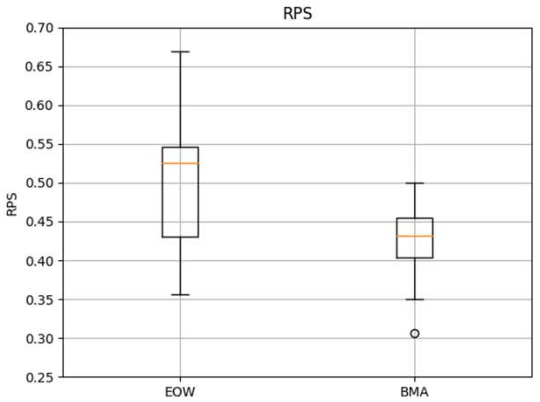
溫度綜合預報-三分類預報

Org

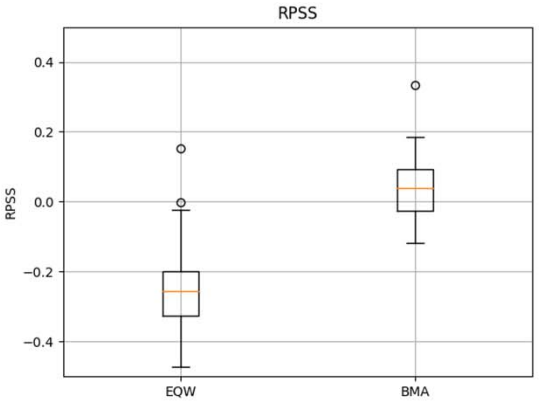
Ano

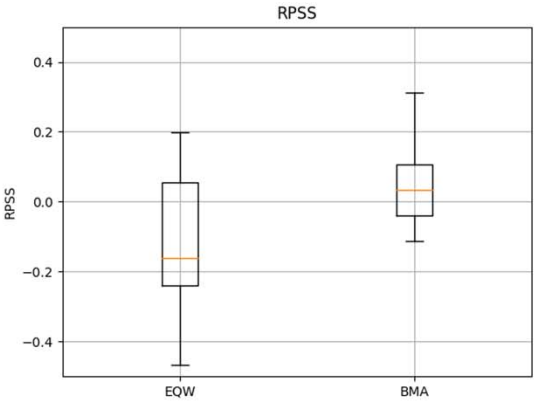
RPS=0最佳



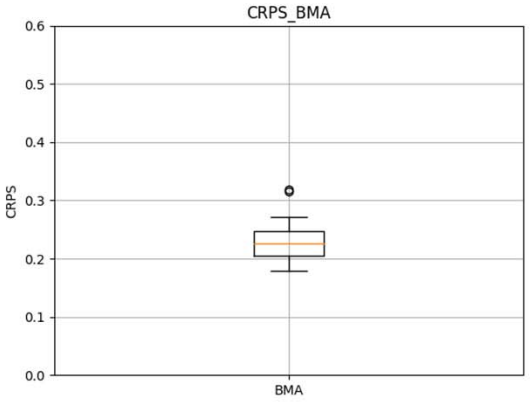


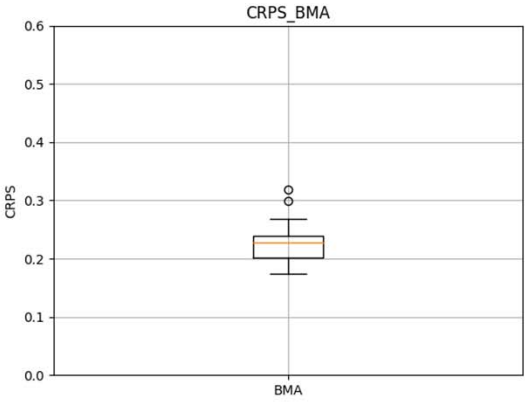
RPSS=1最佳





CRPS=0最佳

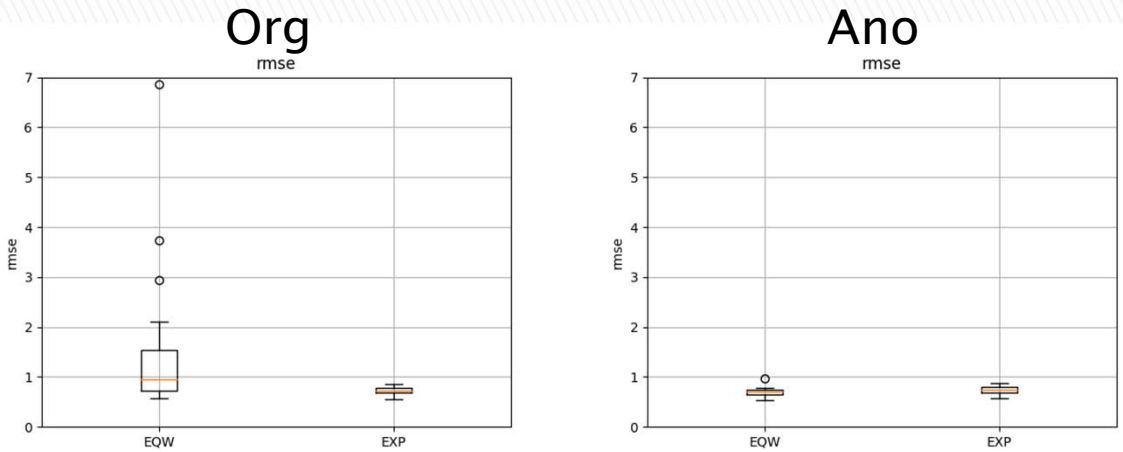




結論

- BMA使用原值或距平值序列建模結果差異不大，反觀EQW必須先行扣除氣候場將誤差壓縮在距平變化範圍內方可得到和BMA在定量上相當的結果
- BMA具有完整PDF可提供PIT、CRPS等機率校驗圖集，而EQW則必須將預報因子作常態分布假設
- BMA提供完整PDF可嘗試以不同百分位數做預報改善預報成效

RMSE



後續工作

- 可改以所有測站一起建模(分山區平地/分地區)，一方面可增加訓練期資料量求得預報模型最佳解，另一方面可避免相鄰站同樣預報因子權重差異過大導致預報結果在物理上無法解釋
- 增加可靠度圖(Reliability Diagram)、ROC圖完善機率預報校驗成果
- 增加和臺灣測站溫度具有高相關的海溫指標，可望提升BMA預報能力

簡報結束 感謝聆聽

分位數映射法(QM)誤差來源說明

- 樣本數太少建立的CDF函數形狀較不連續，容易產生誤差。
- 當模式預報值落在CDF範圍以外之極值處理。
- CDF函數形狀斜率差異過大，使得分位數即便移動相同百分位，變數變動的幅度卻不同，造成校正誤差。
- 最主要的影響因素為模式的分位數與觀測的分位數之差異。