



# 頻率配對法應用於台灣地區風速 網格預報校正

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<sup>2</sup>交通部中央氣象局



# 大綱

- WRF風速格點預報誤差分析
- 頻率配對法介紹
- 頻率配對法結果
- 頻率配對法與誤差衰變平均法比較
- 結論

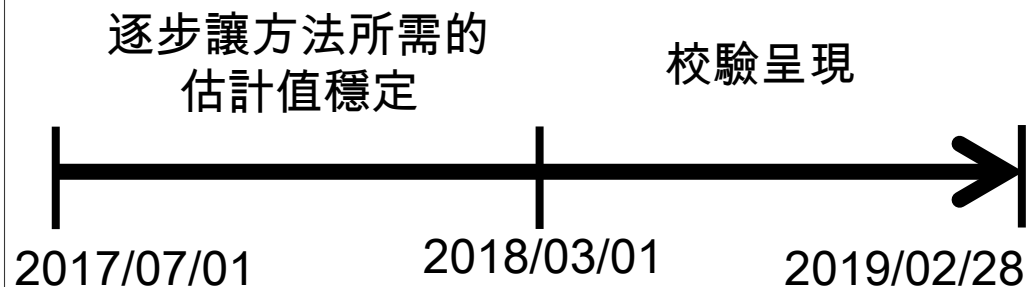
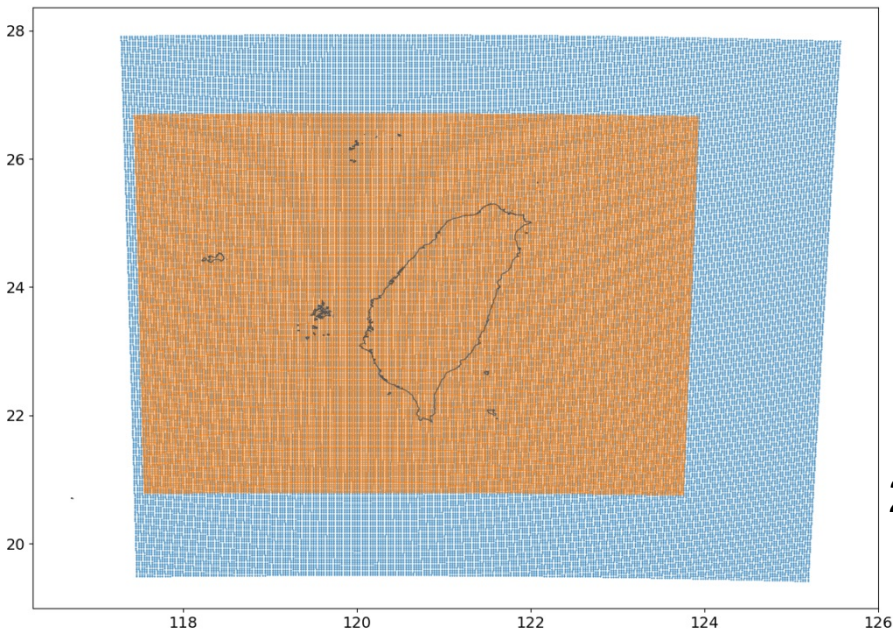


# 研究動機

- 要找一個適用於風速修正的方式，風速誤差隨著風速不同而有變化(Cassola et al., 2012)，而我們通常較關心風速相對大的事件。
- 移除定值誤差的方式可以降低平均絕對誤差(Cheng and Steenburgh 2007, Cui et al, 2012)，但是對台灣地區較大風速的格點預報是否同樣有效則不確定，用風速的多項式描述誤差可能可行，但是得逐格點做分析。
- 因此測試可隨風速大小給予不同幅度調整，並且調整幅度為非線性的頻率配對法(Frequency-Matching Method)，是否適用於台灣地區格點預報
- Cassola, F, Burlando, M (2012) Wind speed and wind energy forecast through Kalman filtering of Numerical Weather Prediction model output. Applied Energy 11(99): 154–166.
- Cheng, W. Y. Y., and W. J. Steenburgh, 2007: Strengths and weaknesses of MOS, running mean bias removal, and Kalman filter techniques for improving model forecasts over the western United States. Wea. Forecasting, 22, 1304–1318, doi:10.1175/2007WAF2006084.1
- Cui, B., Z. Toth, Y. Zhu, and D. Hou, 2012: Bias correction for global ensemble forecast. Wea. Forecasting, 27, 396–410, doi:10.1175/WAF-D-11-00011.1



# 本報告中所使用之資料



模式預報場: 氣象局內作業用WRF 3KM解析度風速預報 (圖中藍色)

分析場資料: 氣象局2.5KM解析度風速分析場 (圖中橘色)

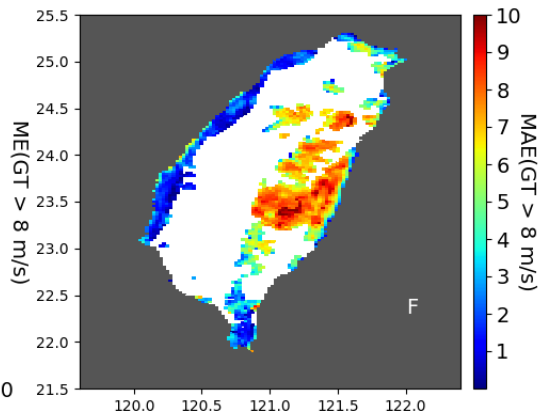
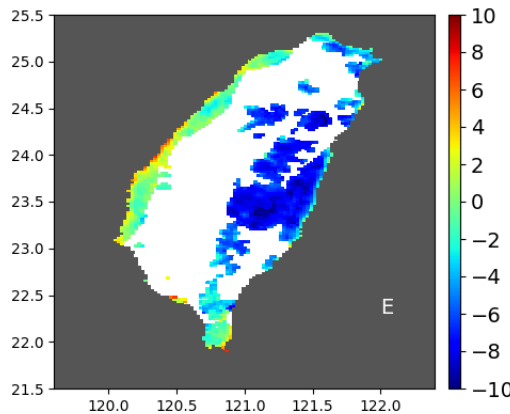
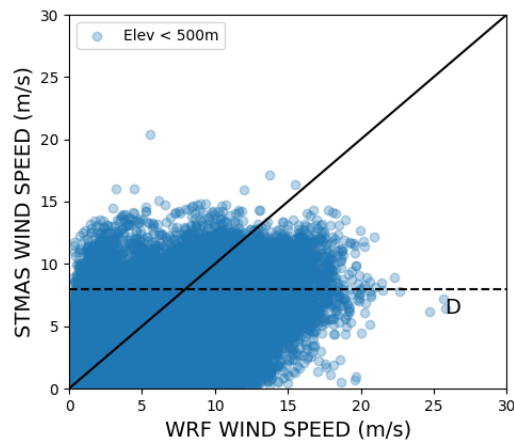
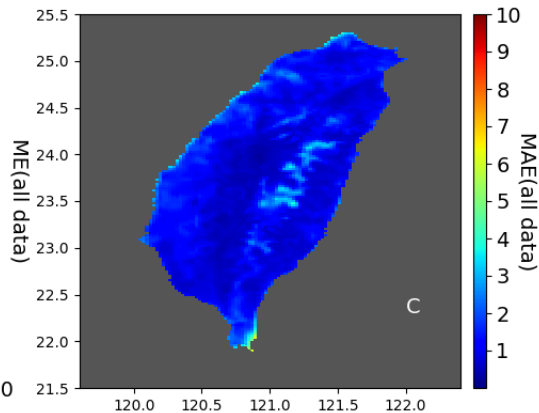
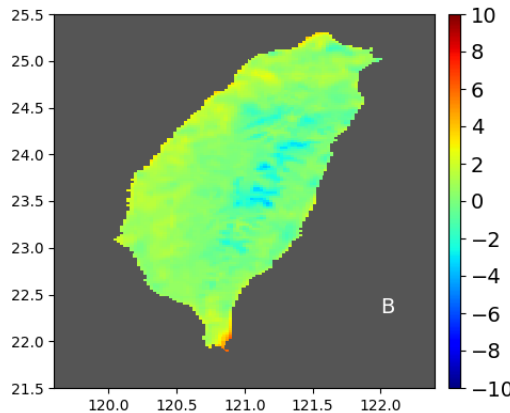
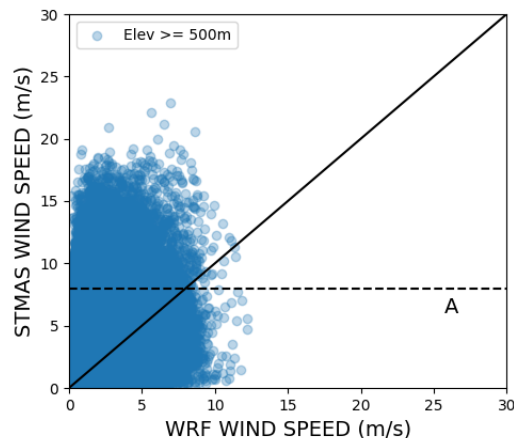
降尺度方式: 線性內插 (使用python套件scipy.interpolate.griddata)

資料時間: 2017/01/01 – 2019/02/28

校驗呈現時間: 2018/03/01 – 2019/02/28

# 氣象局內 3KM WRF對風速分析場誤差分析，預報時間24小時，起始時間每日UTC 00:00

20170101 to 20190228, 00Z, TAU024, UTC-HH00



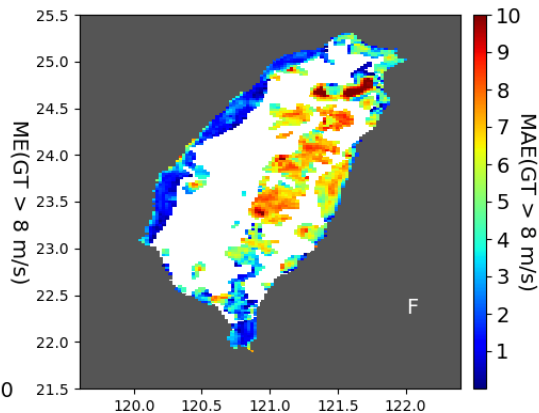
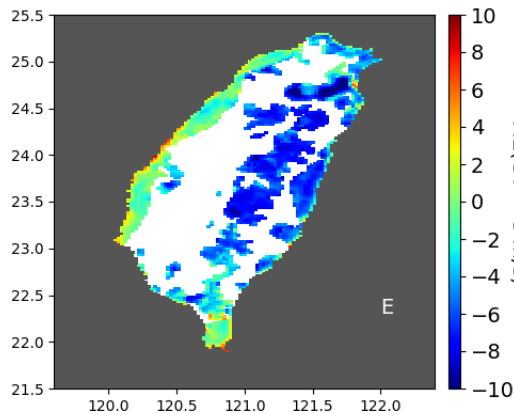
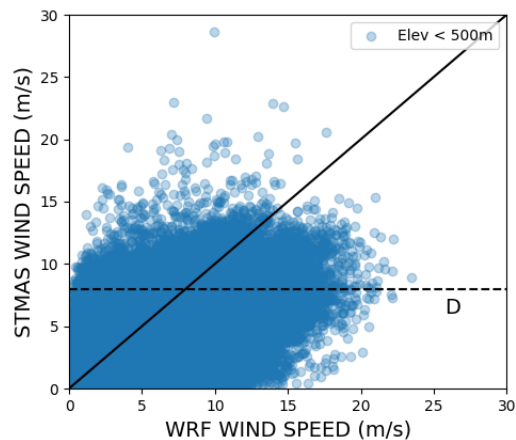
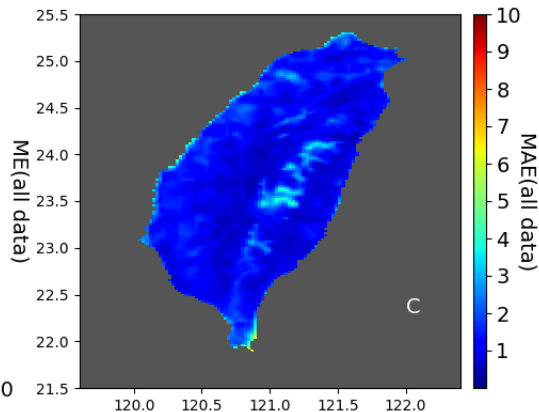
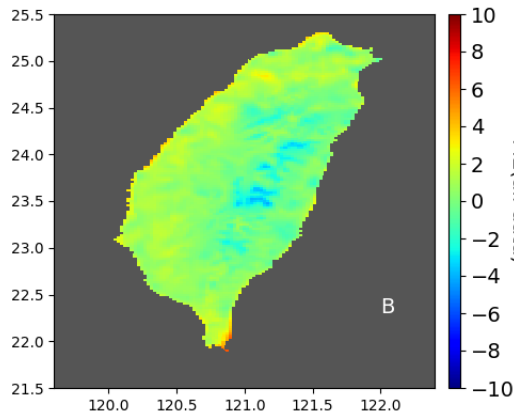
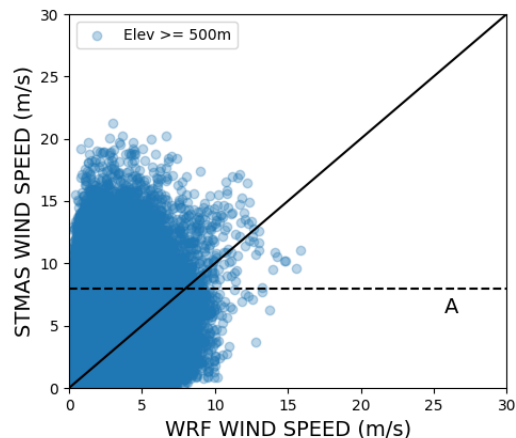
不同高度下的誤差分布

以平均誤差看偏差分布

比較各區域平均絕對誤差

# 氣象局內 3KM WRF對風速分析場誤差分析，預報時間24小時，起始時間每日UTC 12:00

20170101 to 20190228, 12Z, TAU024, UTC-HH12



不同高度下的誤差分布

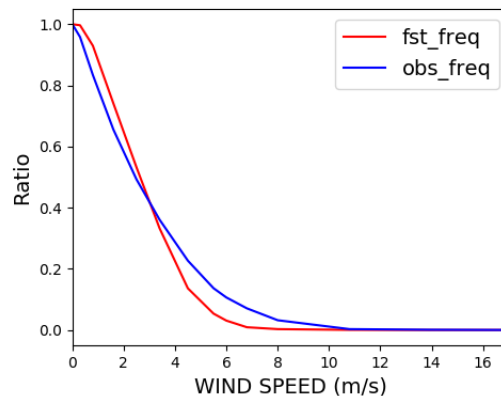
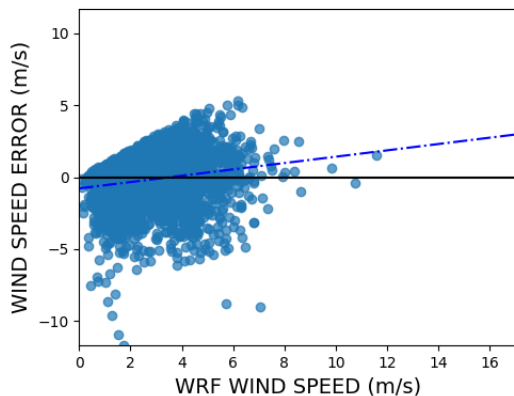
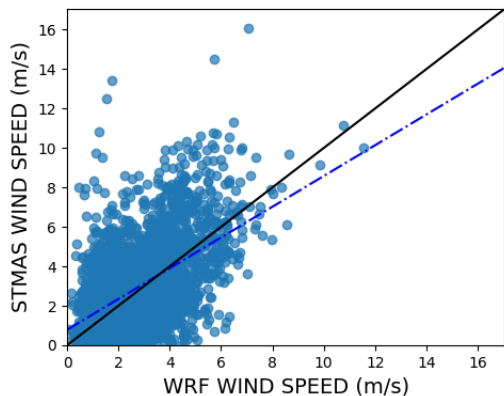
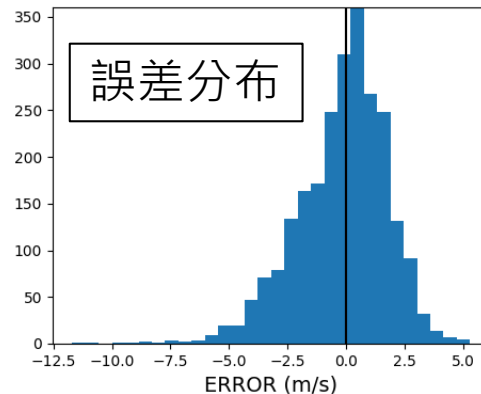
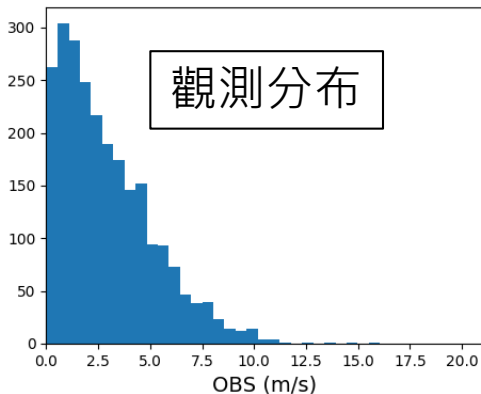
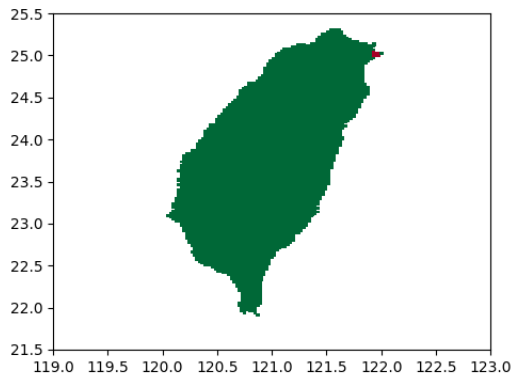
以平均誤差看偏差分布

比較各區域平均絕對誤差

# 台灣地區隨著格點不同，誤差行為的變化大

## 紅色格點的資料分析

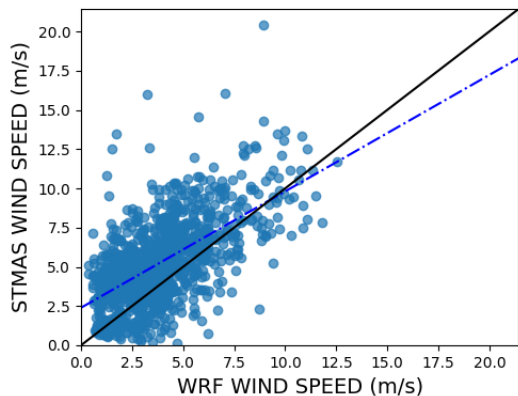
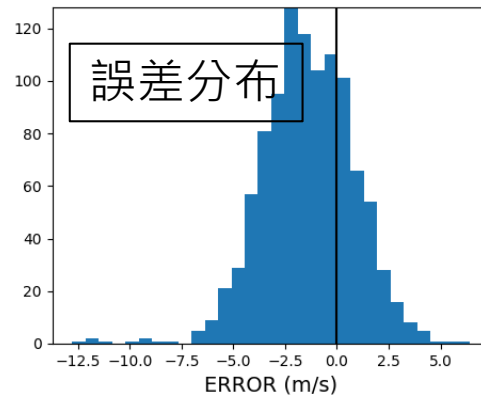
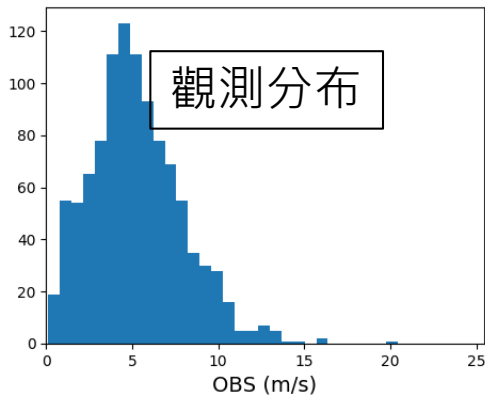
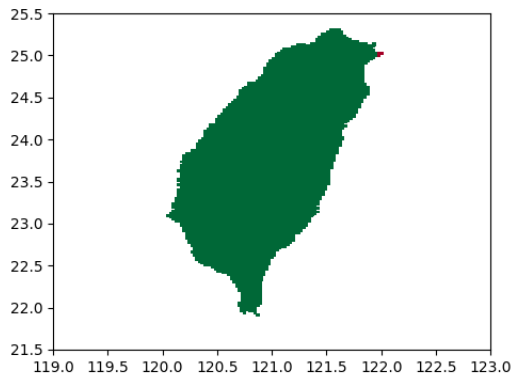
20180101 to 20181231, 00Z, TAU024, UTC-HH00



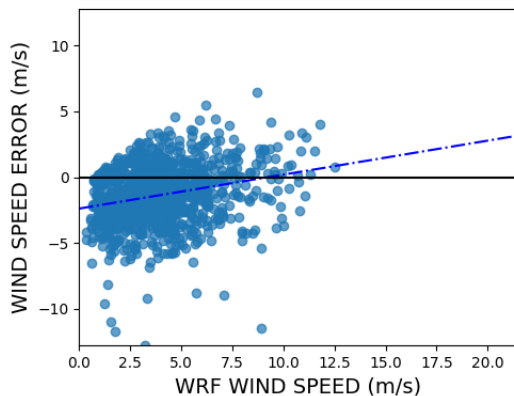
# 台灣地區隨著格點不同，誤差行為的變化大

## 紅色格點的資料分析

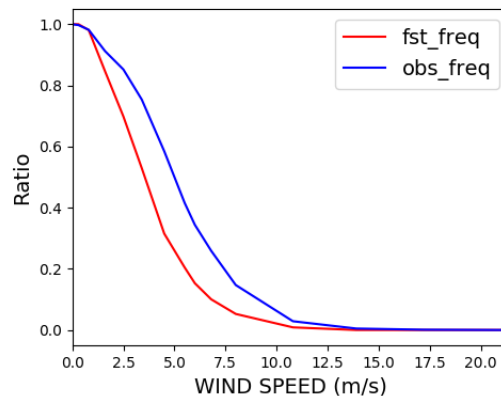
20180101 to 20181231, 00Z, TAU024, UTC-HH00



預報對分析場分布



預報對誤差分布



風速頻率分布



### 8 Precipitation Calibration Based on the Frequency-Matching Method

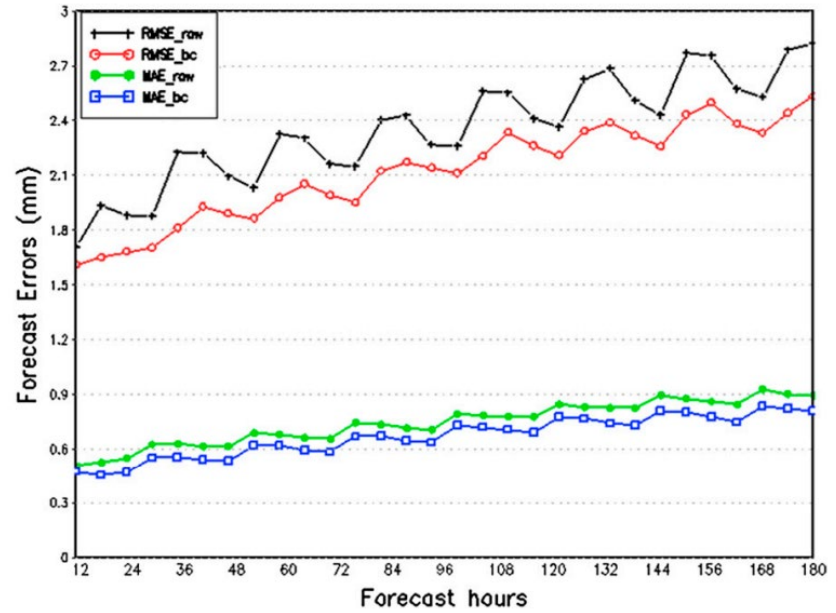
YUEJIAN ZHU

*NOAA/NWS/NCEP/Environmental Modeling Center, College Park, Maryland*

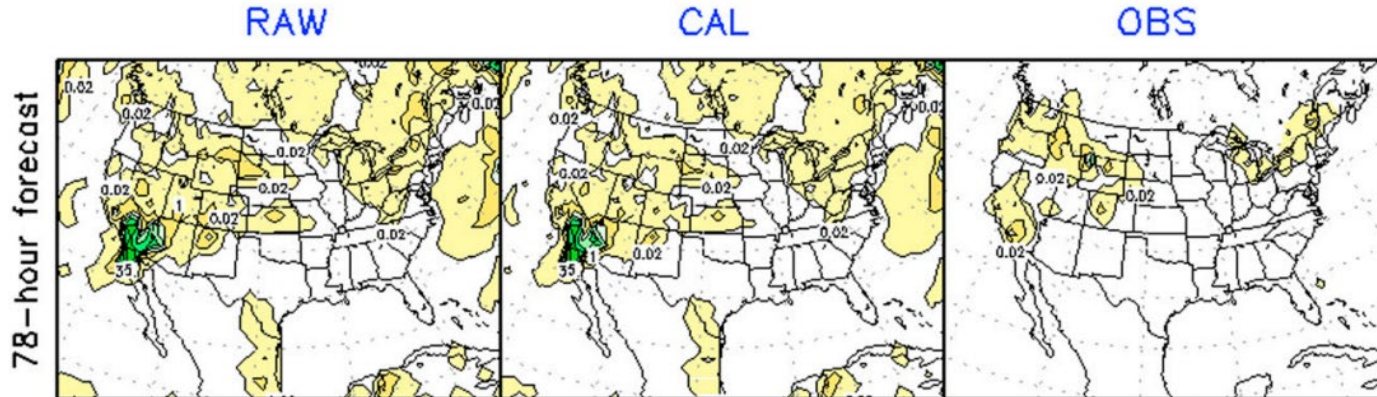
YAN LUO

*NOAA/NWS/NCEP/Environmental Modeling Center, and I. M. Systems Group, Inc., College Park, Maryland*

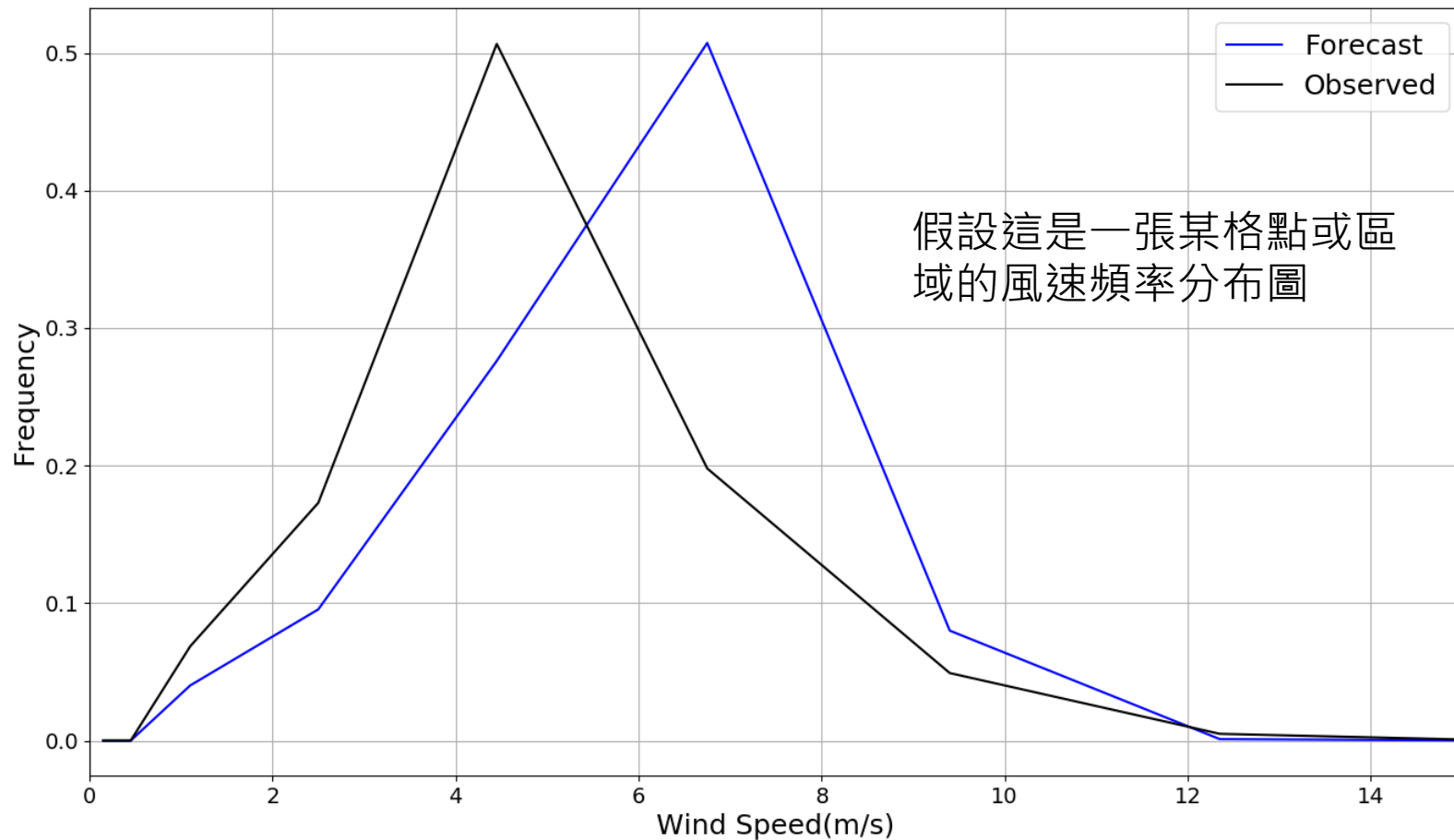
(Manuscript received 26 April 2013, in final form 19 May 2014)



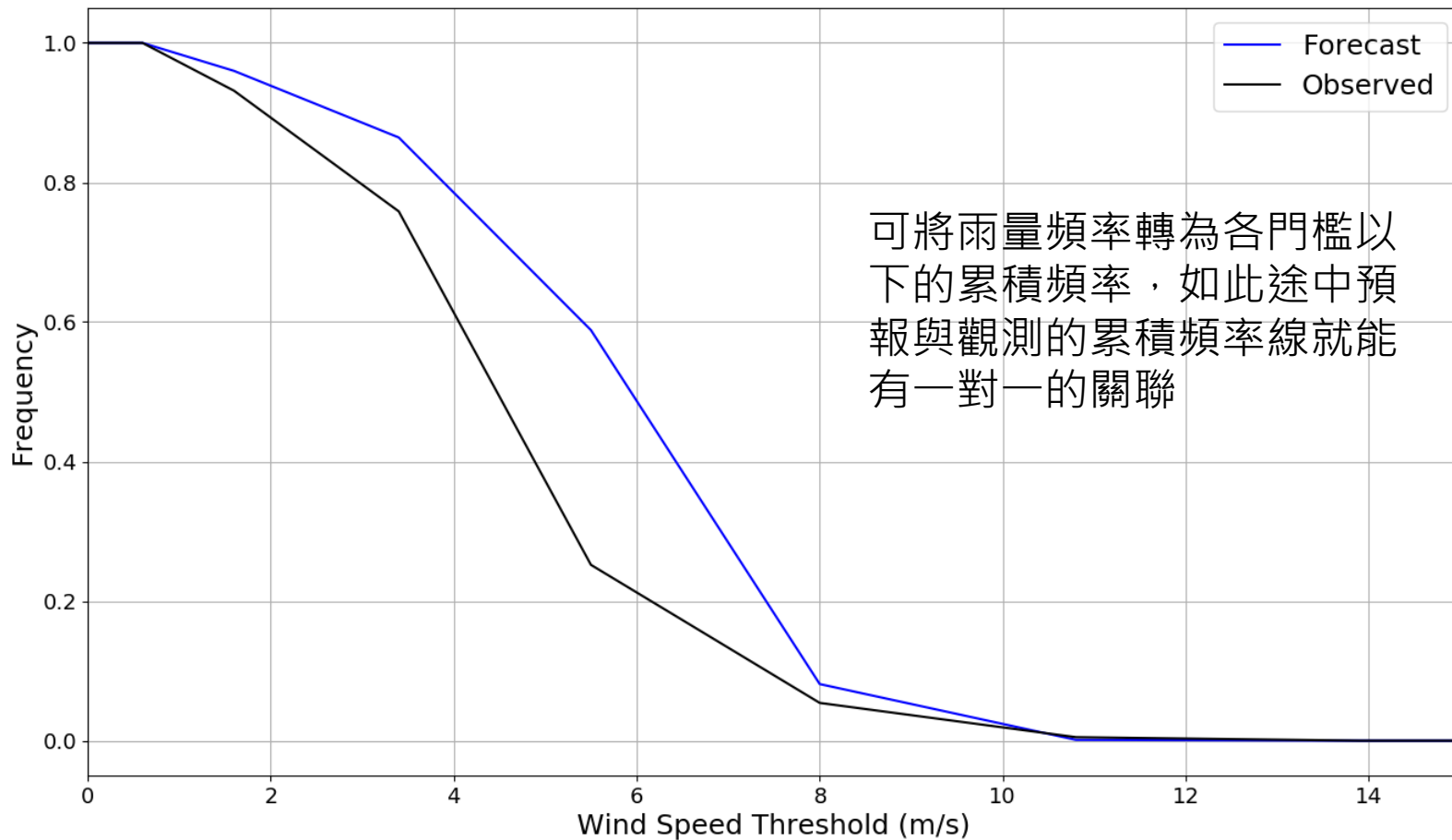
## NCEP/GFS Quantitative Precipitation Forecast (QPF) Ini: 2010012400



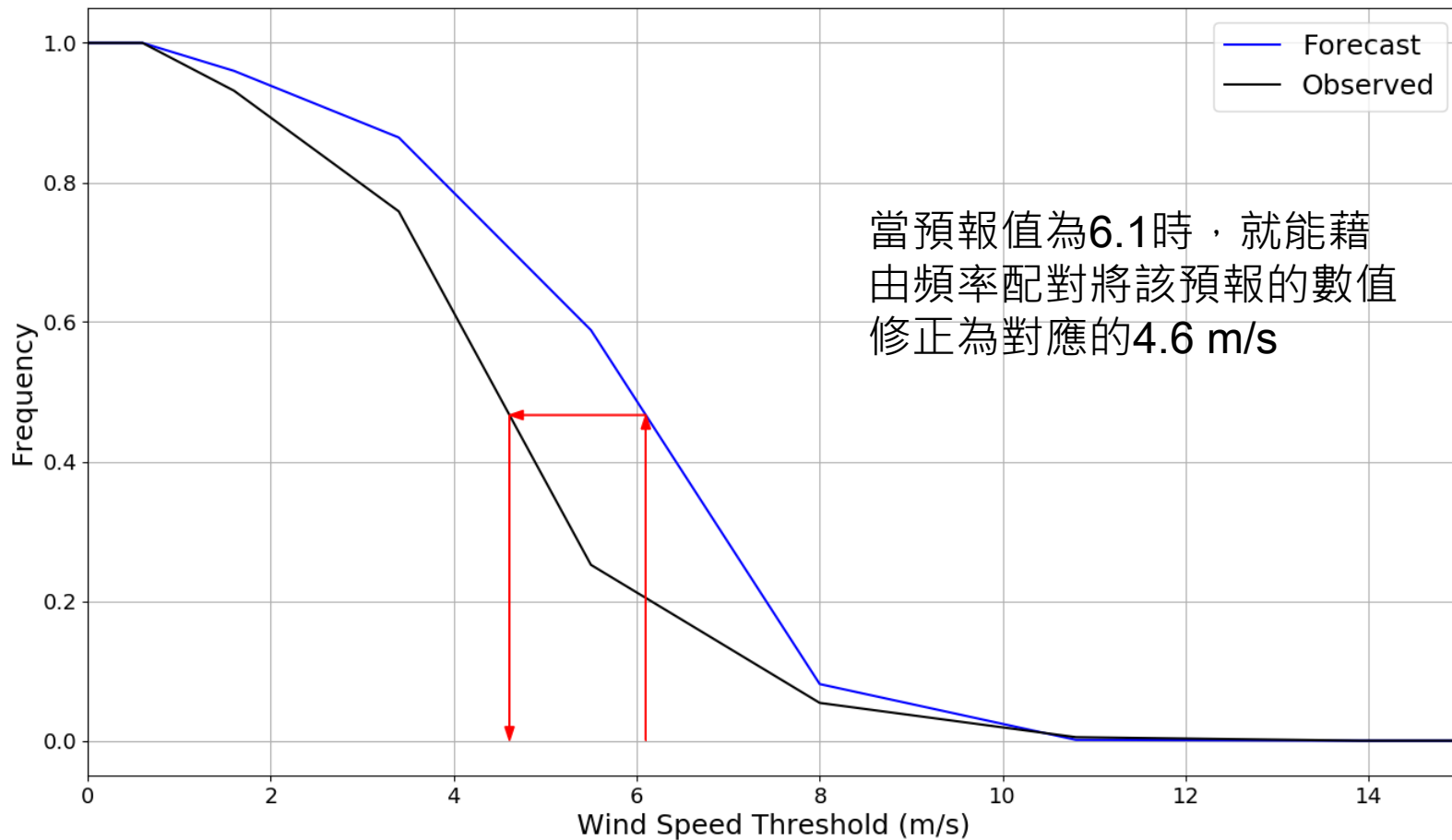
# 頻率配對法介紹 – 頻率配對與預報校正(1/3)



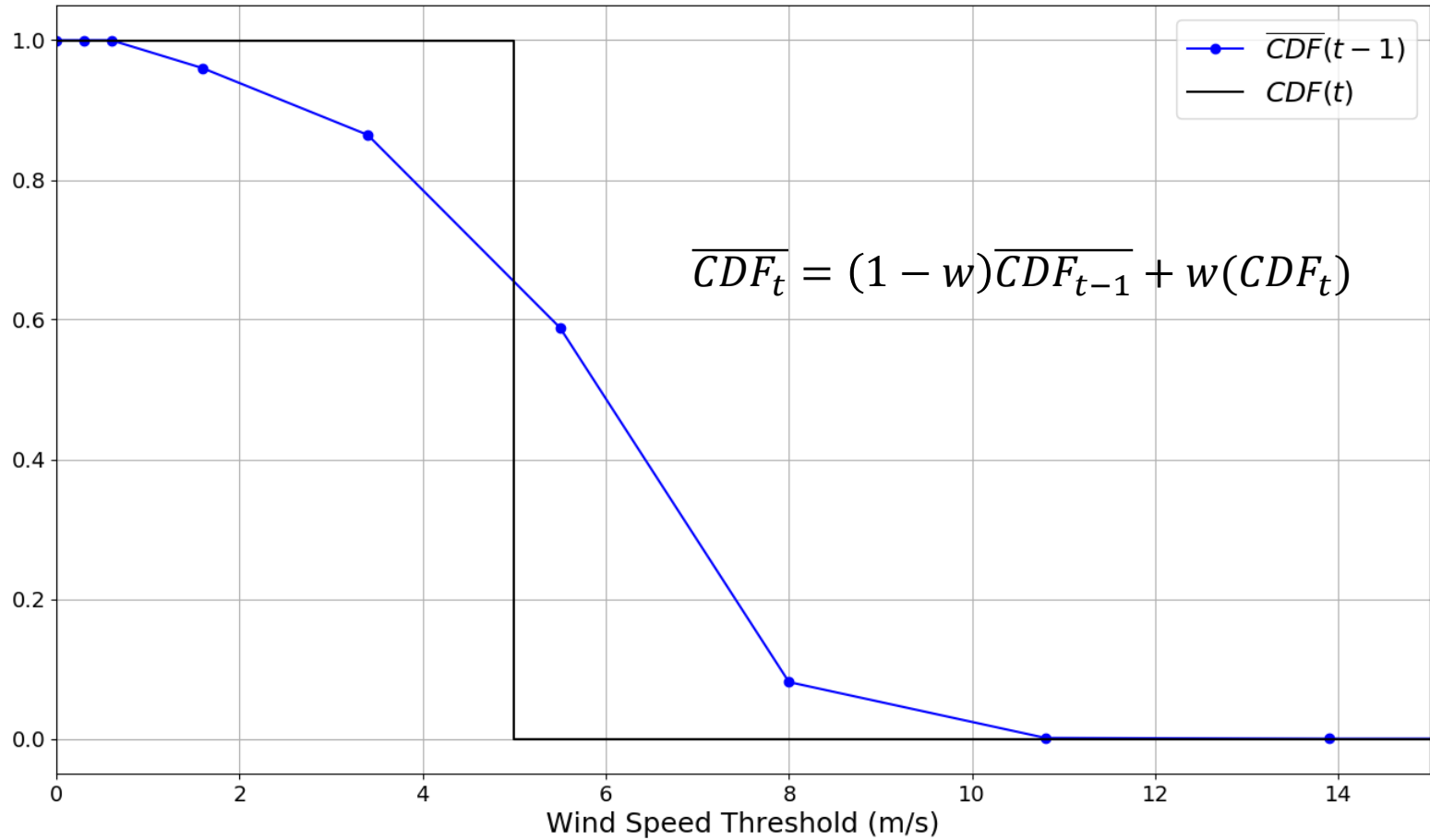
## 頻率配對法介紹 – 頻率配對與預報校正(2/3)



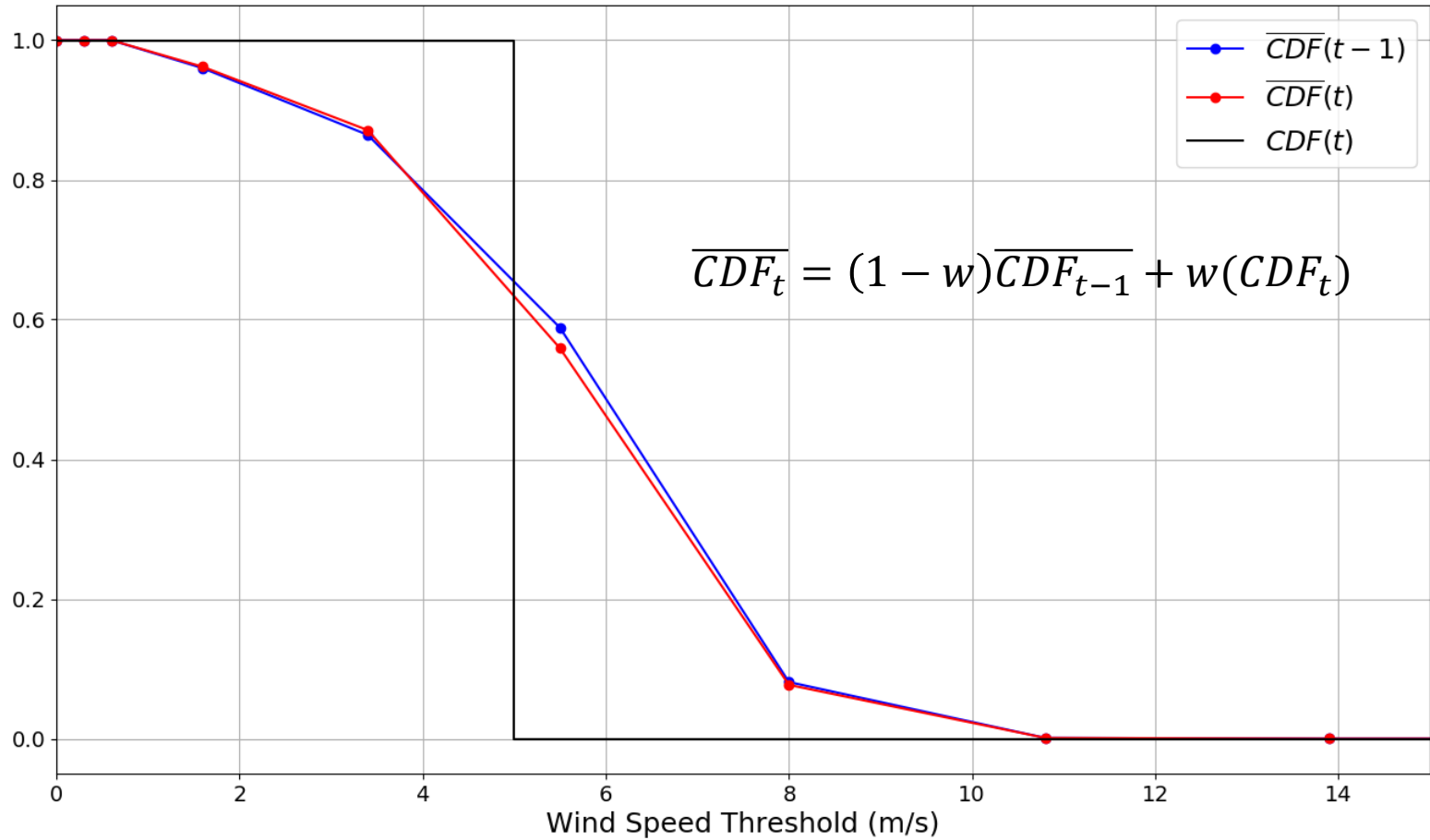
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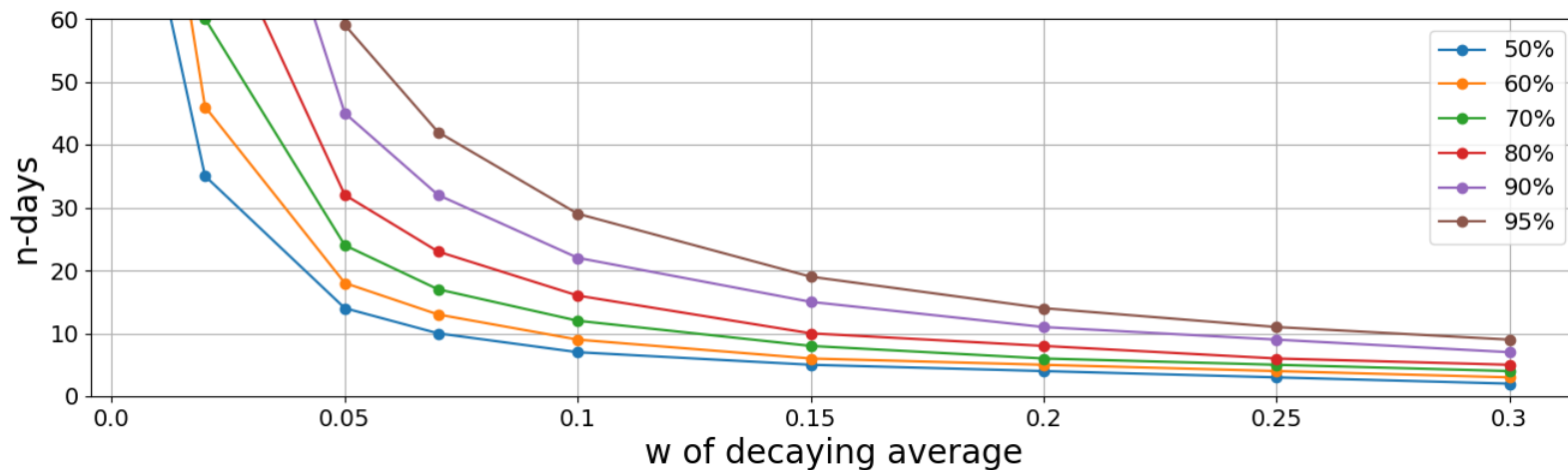
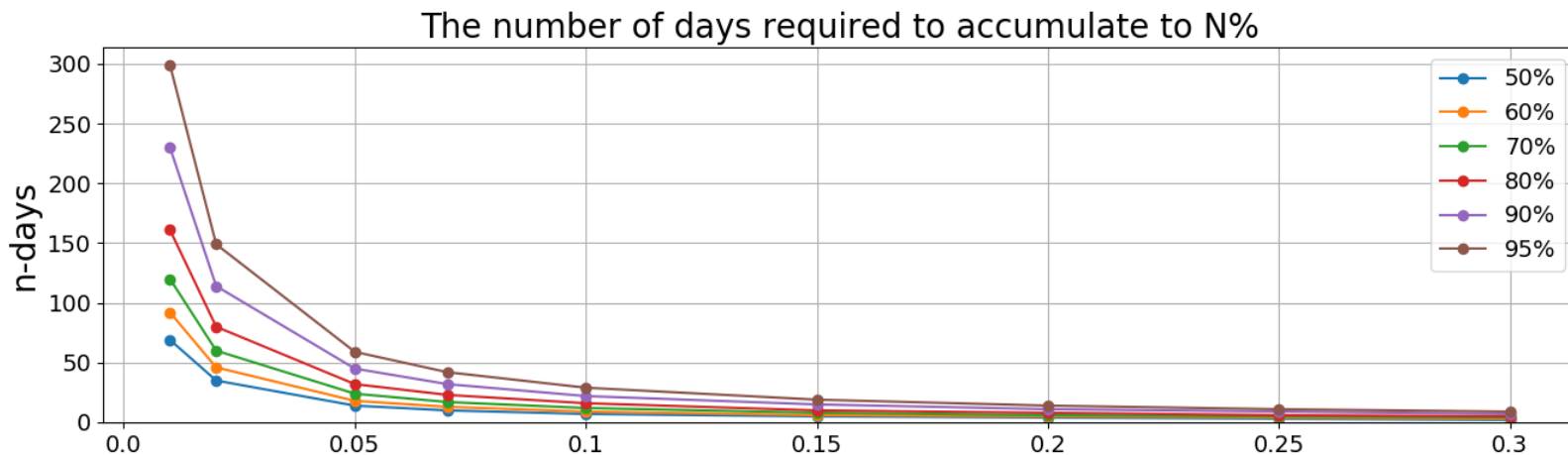
# 頻率配對法介紹 – 累積分布函數逐步調整(1/2)



# 頻率配對法介紹 – 累積分布函數逐步調整(2/2)



# 時間權重 $w$ 與近日估計值佔整體估計值的百分比關係圖

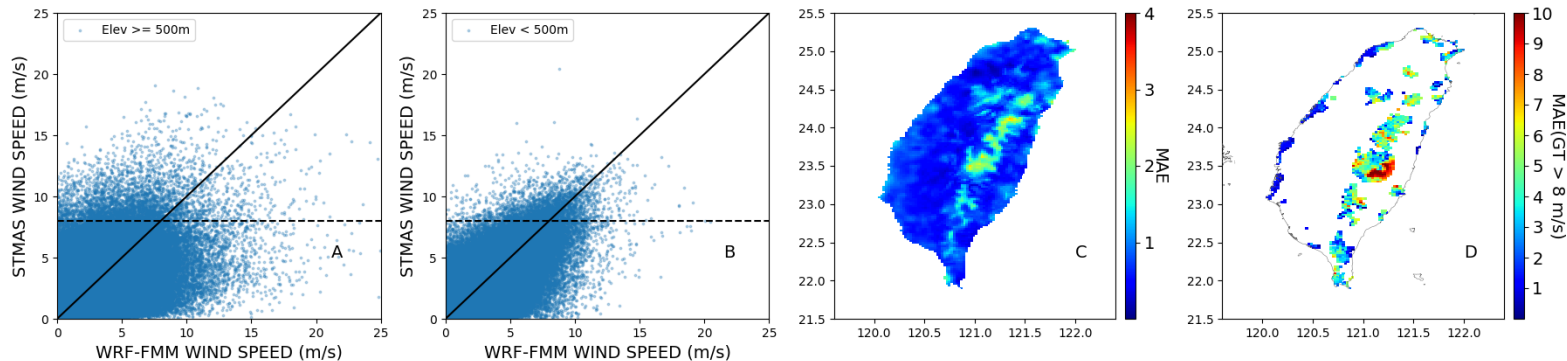


# Frequency-Matching Method 之修正結果

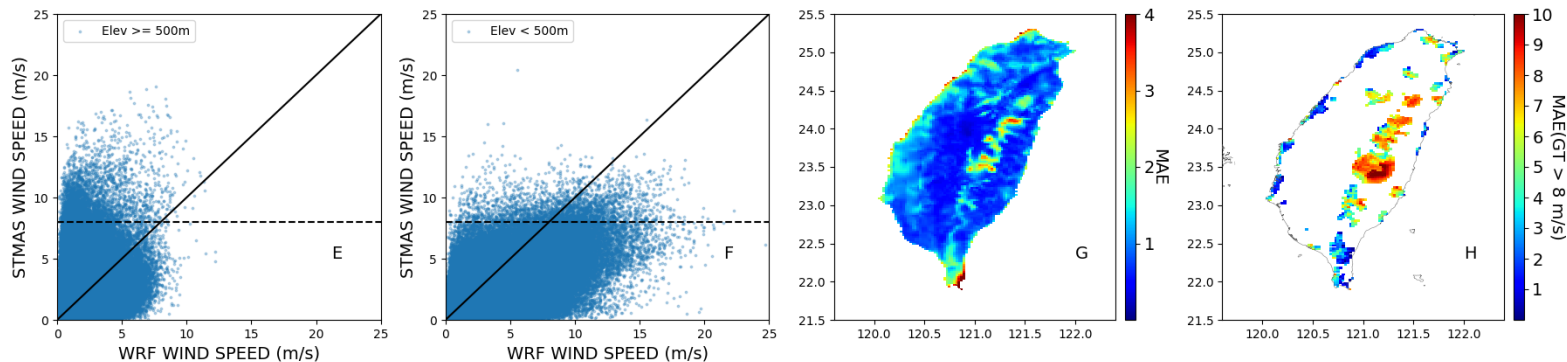
## 每日UTC 00:00之預報，預報時間24H，對應本地時間08:00

20180301 to 20190228, 00Z, TAU024, UTC-HH00

修正後  
→



修正前  
→



預報對觀測值分布圖，依海拔  
500m為界線分為兩張圖

整體MAE以及分析場大於8m/s  
資料之MAE

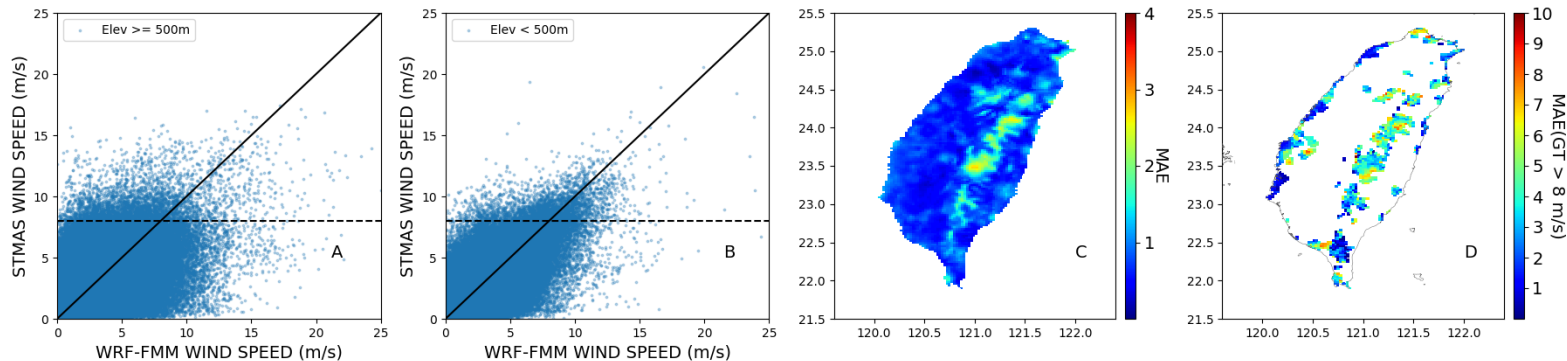


# Frequency-Matching Method 之修正結果

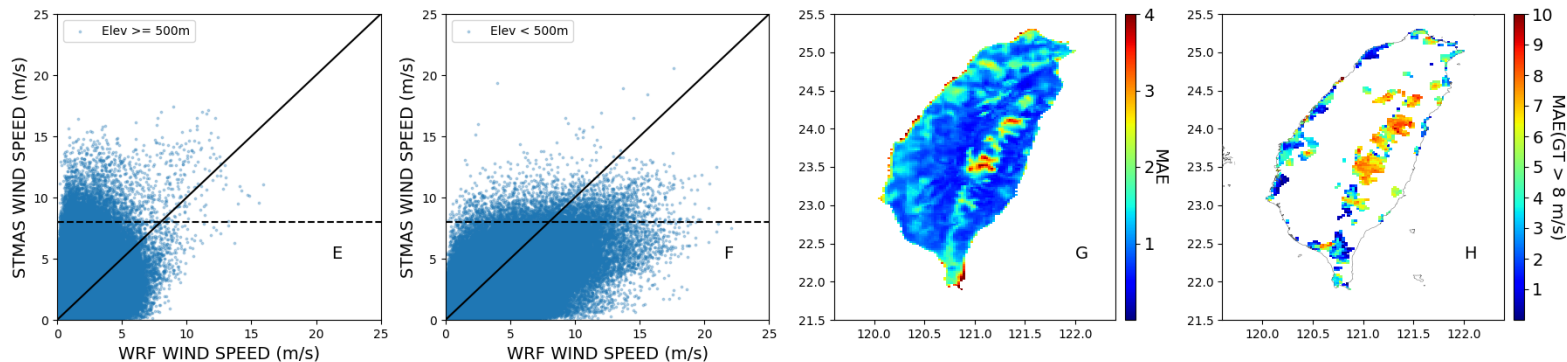
## 每日UTC 12:00之預報，預報時間24H，對應本地時間20:00

20180301 to 20190228, 12Z, TAU024, UTC-HH12

修正後  
→



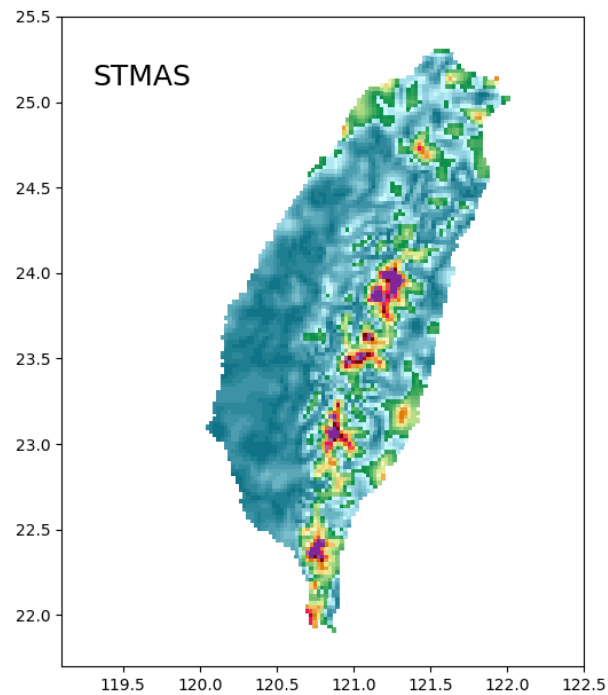
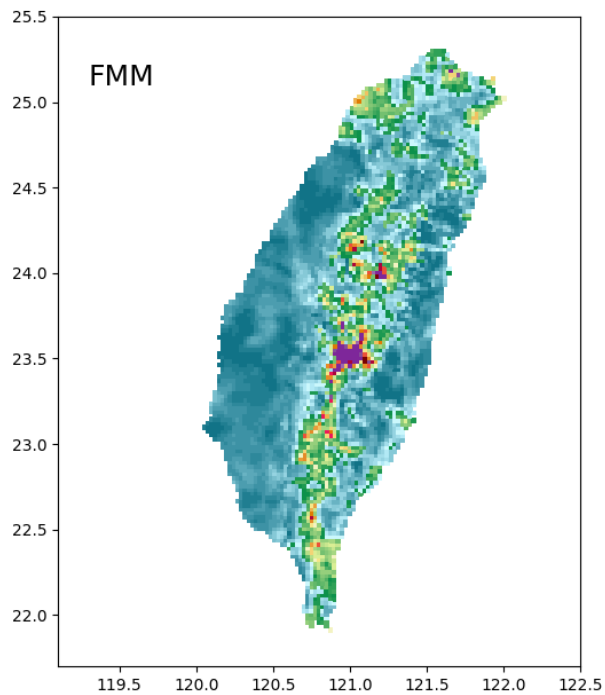
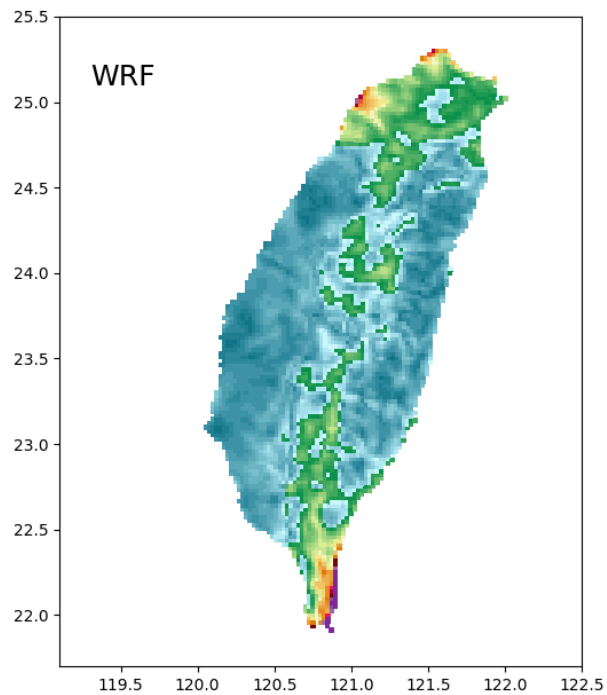
修正前  
→



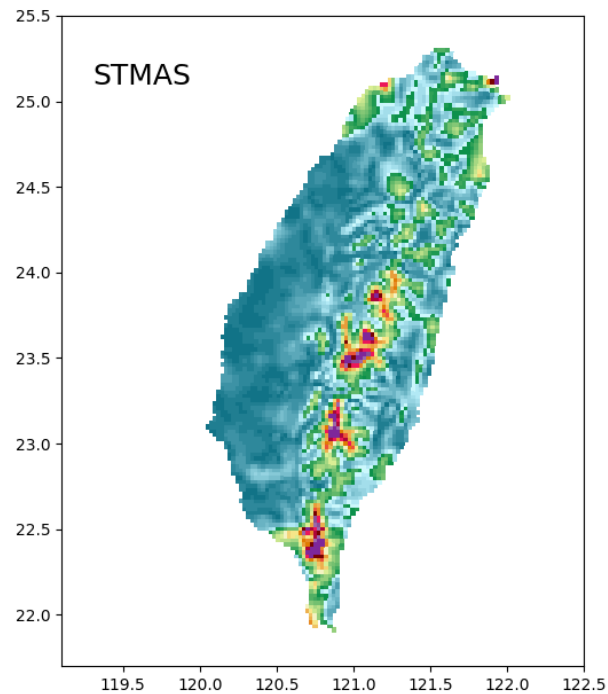
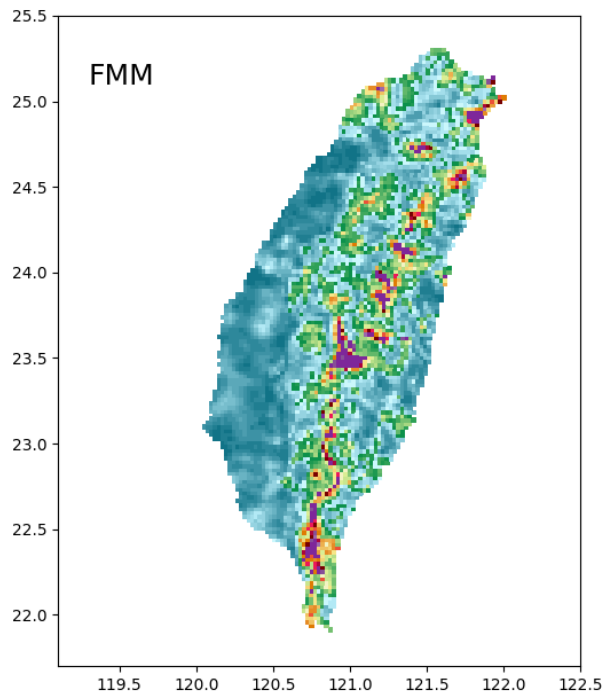
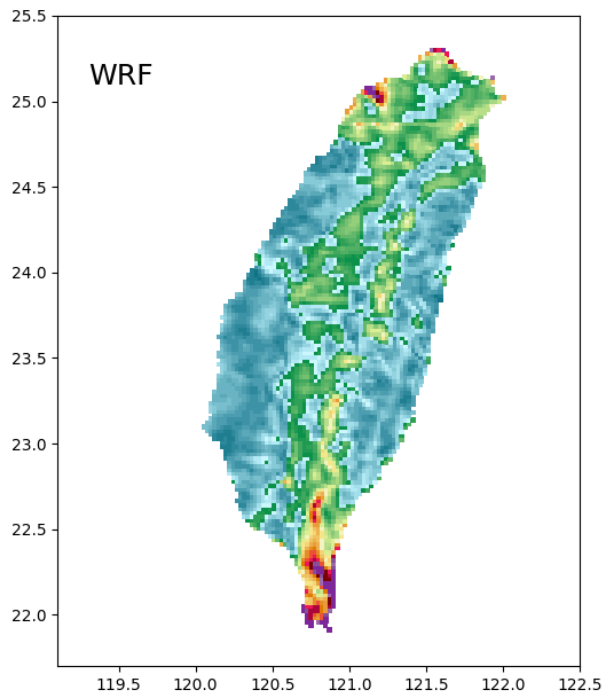
預報對觀測值分布圖，依海拔  
500m為界線分為兩張圖

整體MAE以及分析場大於8m/s  
資料之MAE

FMM forecast, unit: m/s,  
init time(utc):20180914-0000, tau:024, valid time(lst):20180915-0800



FMM forecast, unit: m/s,  
init time(utc):20180914-1200, tau:024, valid time(lst):20180915-2000



# Decaying average bias correction

- 由NOAA的 *Cui* 等人所提出(2012)的誤差修正方法
- 給定一個時間權重  $w$  (介於0~1之間), 並將系統性偏差估計值設定為

$$B_0 = w (b_1 + b_2 (1-w) + b_3(1-w)^2 + b_4(1-w)^3 + \dots)$$

$$B_0 = wb_1 + (1-w) B_1$$

$B_n$  : 第n天的系統性偏差估計值

$b_n$  : 第n天的預報誤差

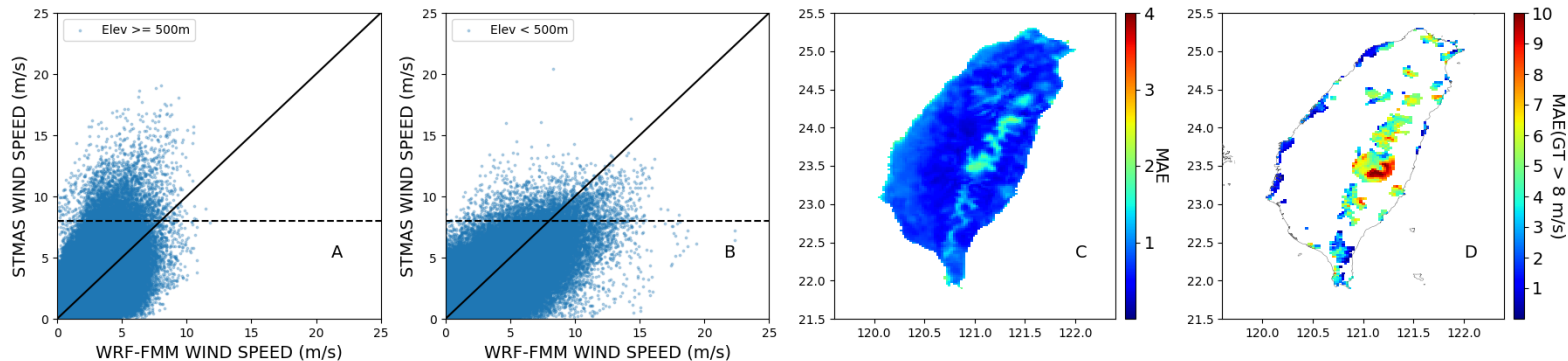
$w$  : 權重係數

# Decaying average bias correction 之修正結果

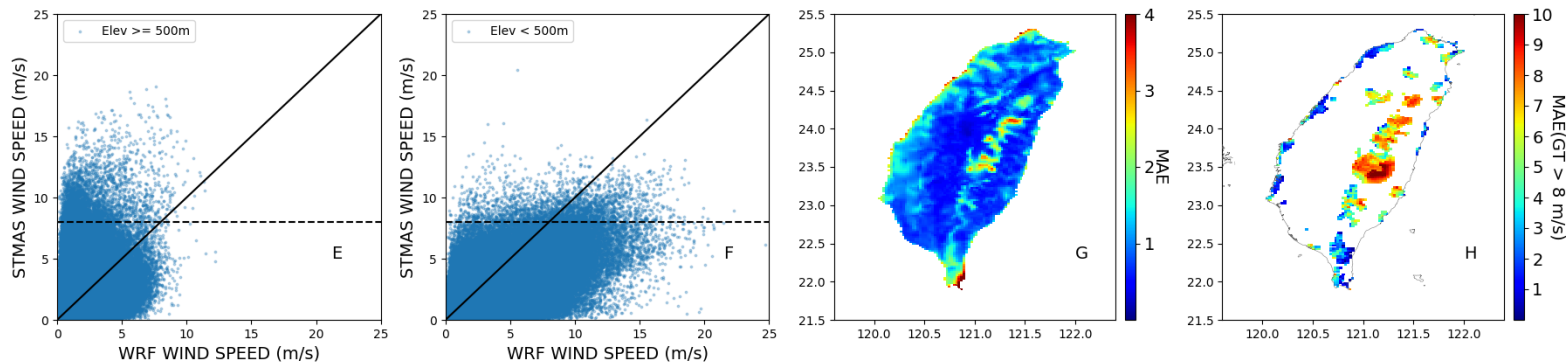
## 每日UTC 00:00之預報，預報時間24H，對應本地時間08:00

20180301 to 20190228, 00Z, TAU024, UTC-HH00

修正後  
→



修正前  
→



預報對觀測值分布圖，依海拔  
500m為界線分為兩張圖

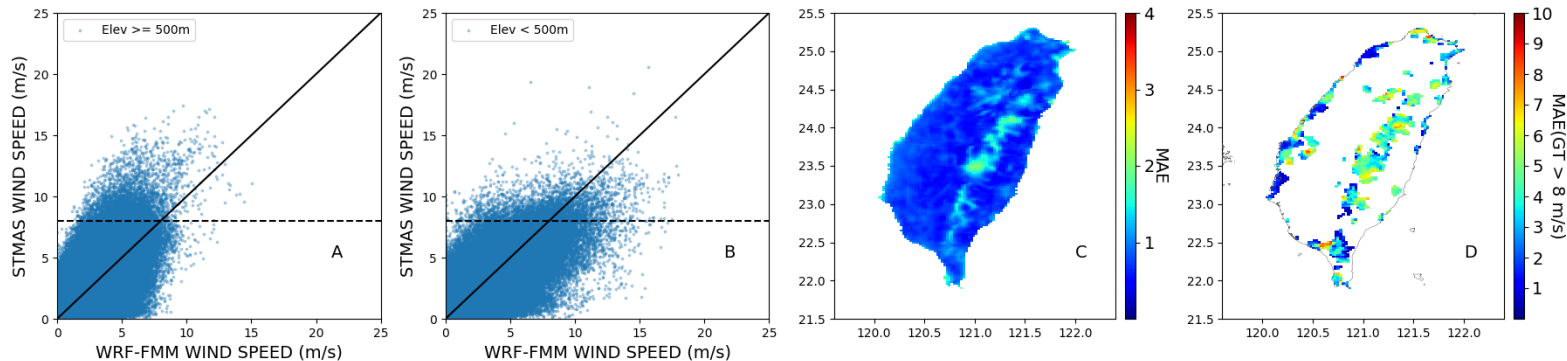
整體MAE以及分析場大於8m/s  
資料之MAE

# Decaying average bias correction 之修正結果

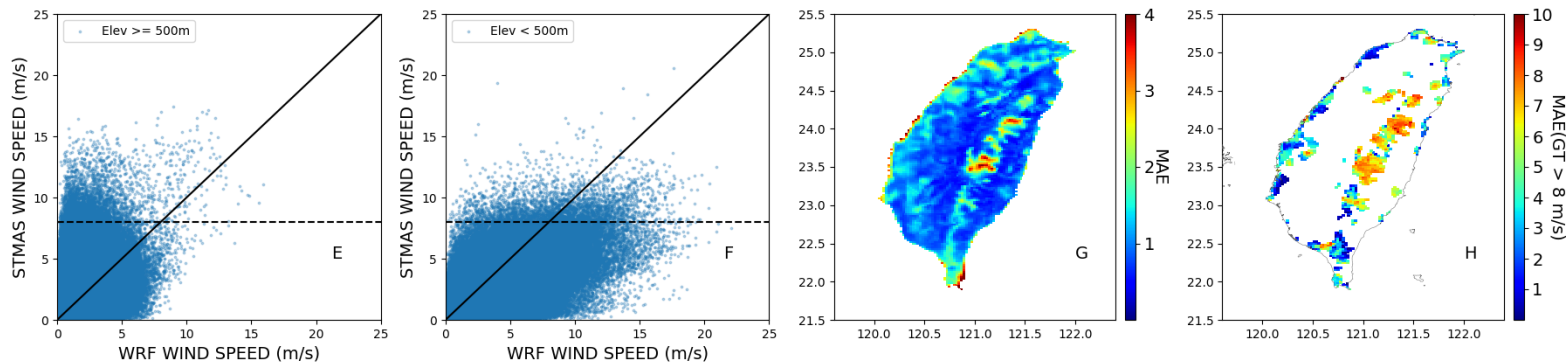
## 每日UTC 00:00之預報，預報時間24H，對應本地時間08:00

20180301 to 20190228, 12Z, TAU024, UTC-HH12

修正後  
→



修正前  
→

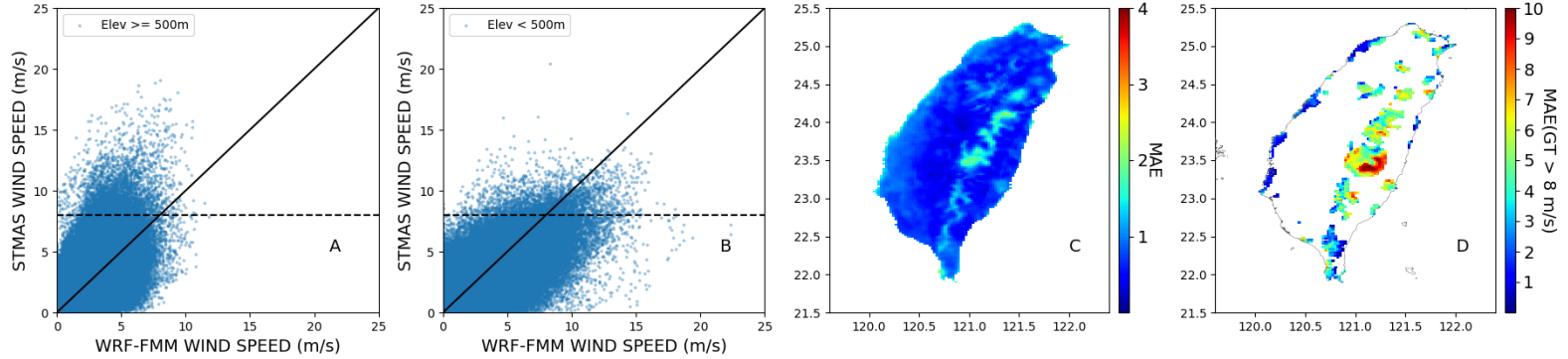


預報對觀測值分布圖，依海拔  
500m為界線分為兩張圖

整體MAE以及分析場大於8m/s  
資料之MAE

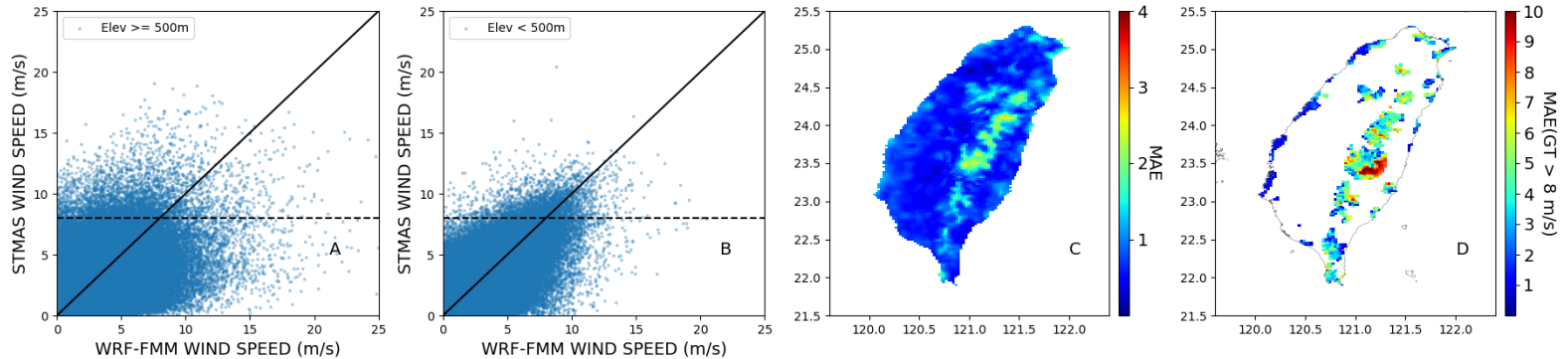
# Decaying Average

20180301 to 20190228, 00Z, TAU024, UTC-HH00



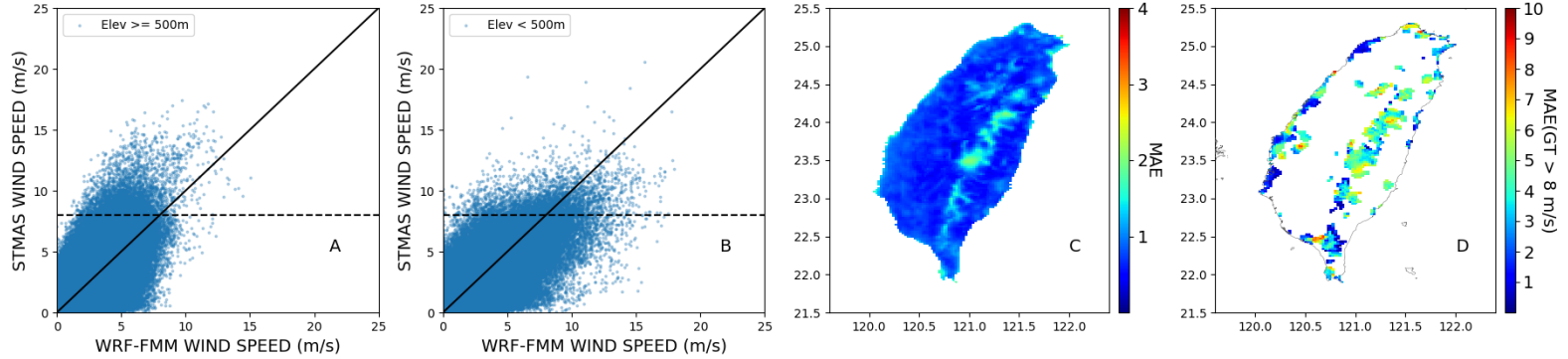
# Frequency-Matching Method

20180301 to 20190228, 00Z, TAU024, UTC-HH00



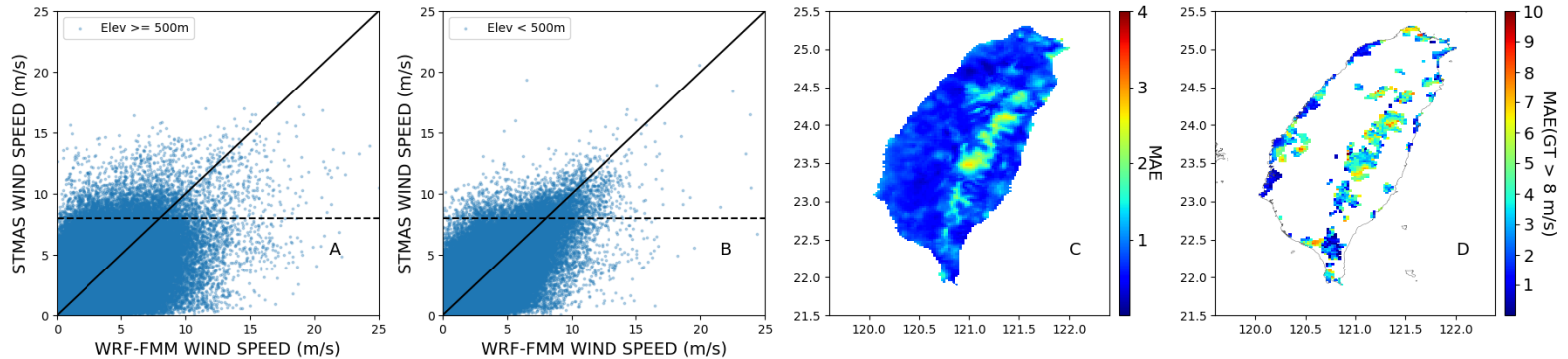
# Decaying Average

20180301 to 20190228, 12Z, TAU024, UTC-HH12



# Frequency-Matching Method

20180301 to 20190228, 12Z, TAU024, UTC-HH12





# 結論

- 頻率配對法可降低風速誤差，在整體或者分析場5級風以上的情況皆有修正效果
- 頻率配對法需要仰賴預報量值的排序與觀測(分析場)具有對應性
- 因為上述原因，頻率配對法對於預報表現較佳的海拔500公尺以下有較好的修正效果，部分海岸地區修正效果更佳
- 山區因模式預報對風速掌握度較低，預報與觀測(分析場)排序上對應性較低，因此產生許多過度修正的情況



感謝聆聽，  
謝謝

