

MRI-AGCM動力降尺度後之颱風變異分析

陳淡容、林宜穎、鄭兆尊、于宜強
國家災害防救科技中心

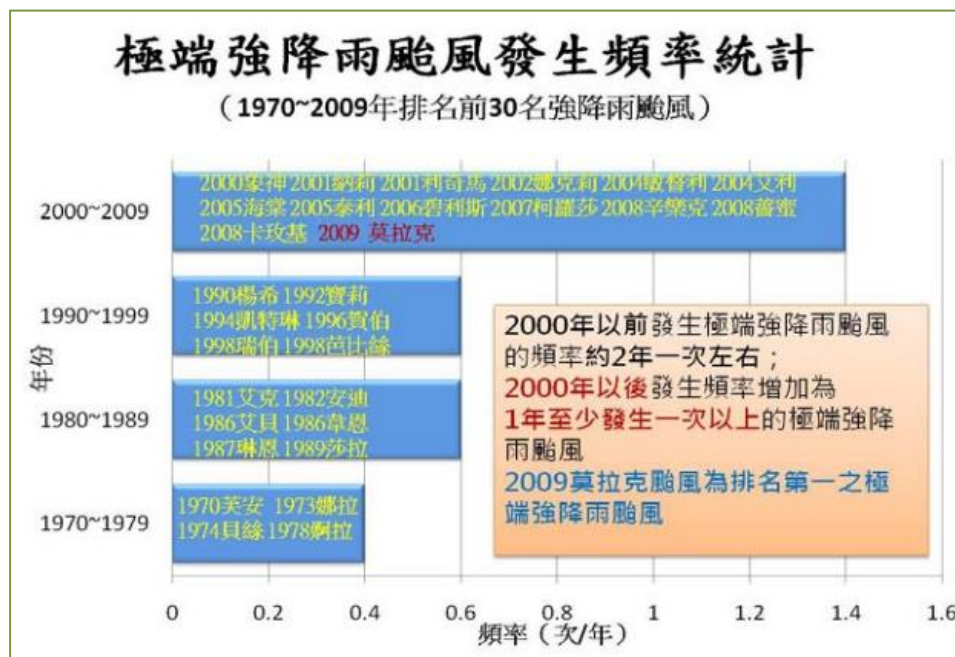
報告大綱

- # 研究背景 (TCCIP計畫、暖化與極端事件)
- # 模式設定與資料說明
- # 研究動機
- # 颱風降雨分析
- # 結論與建議
- # 未來工作

研究背景

近幾年科學家發現過去數十年全球各地溫度增加，強降雨事件亦隨之增多。

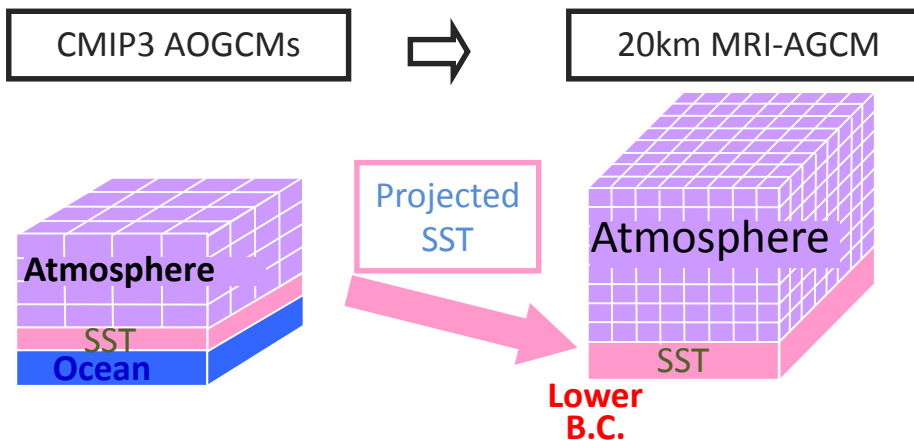
2000年以後發生極端強降雨的颱風頻率有增加的趨勢。



臺灣氣候變遷推估與資訊平台建置計畫 (TCCIP)

模式設定與資料說明

MRI-AGCM 實驗設計



Time-Slice Experiments

MRI-AGCM is a climate model version of the JMA operational NWP models

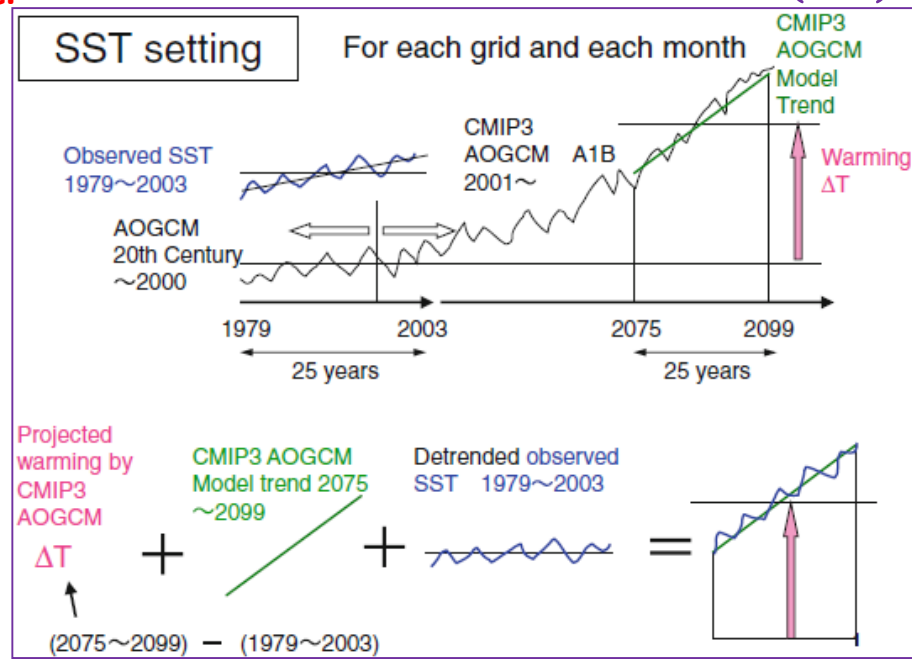
Present (1979-2003)

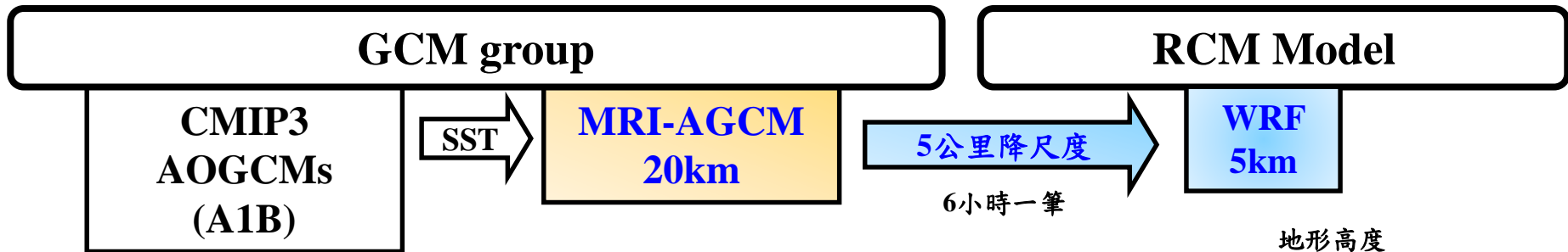
the observed sea surface temperature (SST) and sea-ice concentration

Future (2075-2099)

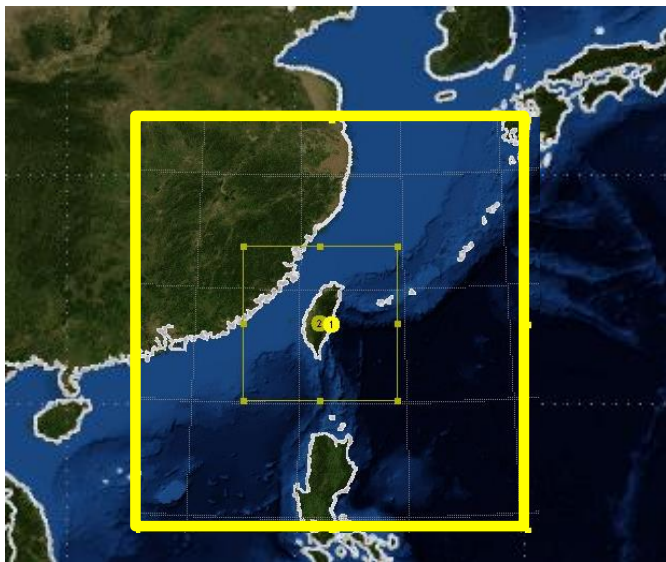
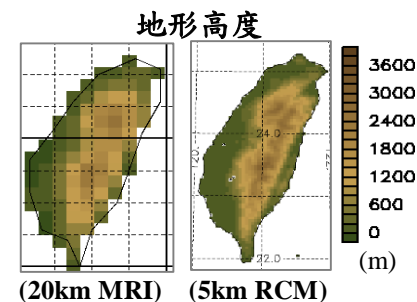
the SST and sea-ice anomalies of the CMIP3 multi-model ensemble mean are added to the observations, retaining the present interannual variability

Kusunoki et al. (2011)





MRI-AGCM(日本氣象廳氣象研究所)
 全球網格數：1920 x 960
 網格間距：20公里
 垂直方向：60層



WRF模式設定

- 5公里動力降尺度之氣候推估模擬採用3個時間切片：
 現在(1979~2003)、近未來(2015~2039)、世紀末(2075~2099)

物理參數化

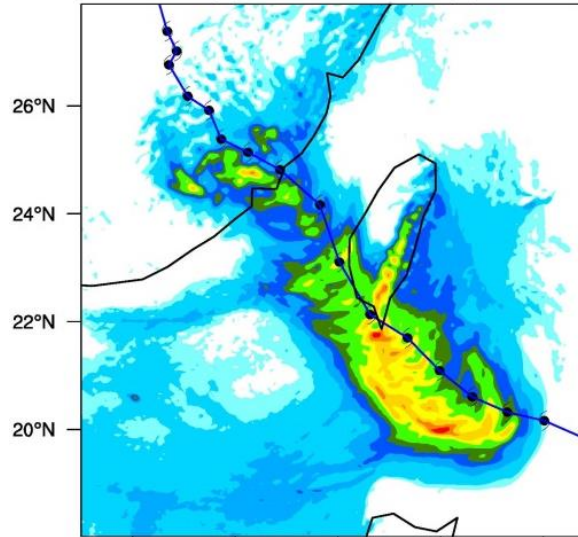
- | | |
|---|---|
| <input type="checkbox"/> Noah land surface module | <input type="checkbox"/> CAM3 LW scheme |
| <input type="checkbox"/> YSU Boundary scheme | <input type="checkbox"/> CAM3 SW scheme |
| <input type="checkbox"/> WSM 5-class microphysics | <input type="checkbox"/> Monin-Obukhov surface layer scheme |
| <input type="checkbox"/> KF cumulus scheme | |
- 為了避免降尺度後的氣候偏移太大，採用”**波譜修正 (spectral nudging)**“方法，僅針對邊界層以上的風場、重力位、水氣場及溫度場做調整。

研究動機

動力降尺度之資料能提供更切實的颱風降雨分布，然而進行動力降尺度時所使用的波譜修正(spectral nudging)會不利於暖季降雨的模擬結果，但不使用波譜修正則會造成颱風路徑的模擬與降尺度前存在相當的差異，此一結果會造成降尺度前後颱風降雨分布不一致。本研究將著重在評估波譜修正的使用與否對動力降尺度之颱風模擬的差異。

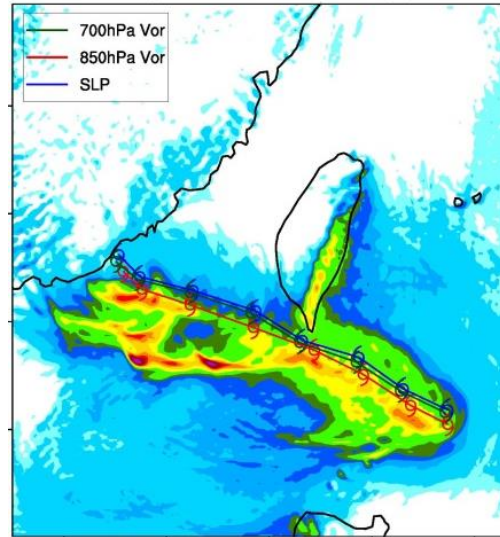
Nudging

1979-07-21_12:00:00 - 1979-07-23_18:00:00

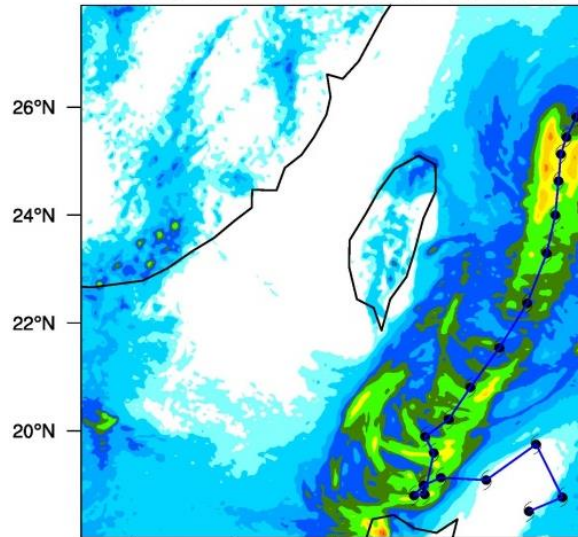


No nudging

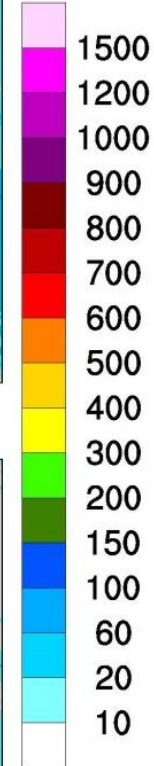
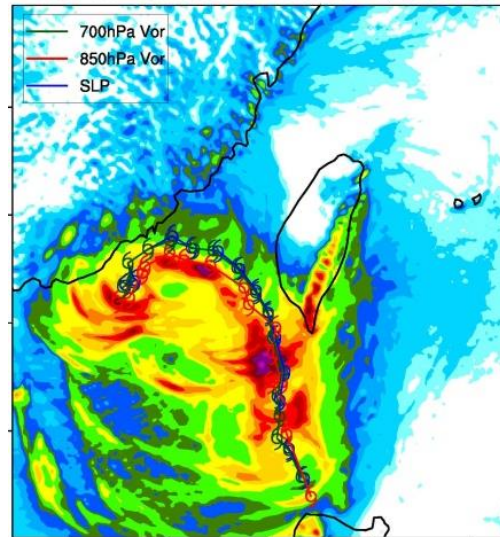
1979-07-21_12:00:00 - 1979-07-23_06:00:00



1980-08-13_12:00:00 - 1980-08-16_12:00:00



1980-08-13_18:00:00 - 1980-08-17_18:00:00



颱風偵測方式

搜尋**850hPa渦度值最大處**，且其值必須超過 $2 \times 10^{-4} \text{ s}^{-1}$ ，以此為最大渦度中心

以最大渦度中心為中心點，取半徑 1° 的範圍內搜尋**海平面氣壓值最低處**，其中該海平面氣壓值須小於998hPa、近中心最大風速要大於17m/s，且該最低海平面氣壓與環境之海平面氣壓差值須達5hPa以上。

以最大渦度中心為中心點，取半徑 1° 的範圍，計算該範圍內**500~200hPa的平均溫度**並搜尋與平均溫度差值最大的網格點，且該溫差須達 0.5°C 以上，該網格點即為暖心中心。此外，高層暖心中心與地面氣壓中心水平距離必須小於 1° ，若超過 1° 則不視為颱風。

颱風追蹤方法

海平面氣壓：由前述利用海平面氣壓定義出之颱風中心，搜尋6小時後距該中心半徑 2° 範圍內海平面氣壓最小處

850hPa相對渦度：由上述利用海平面氣壓追蹤出之颱風中心，搜尋距該中心半徑 1° 範圍內相對渦度最大處

700hPa風場：由上述利用海平面氣壓追蹤出之颱風中心，搜尋距該中心半徑 1° 範圍內風速最小處

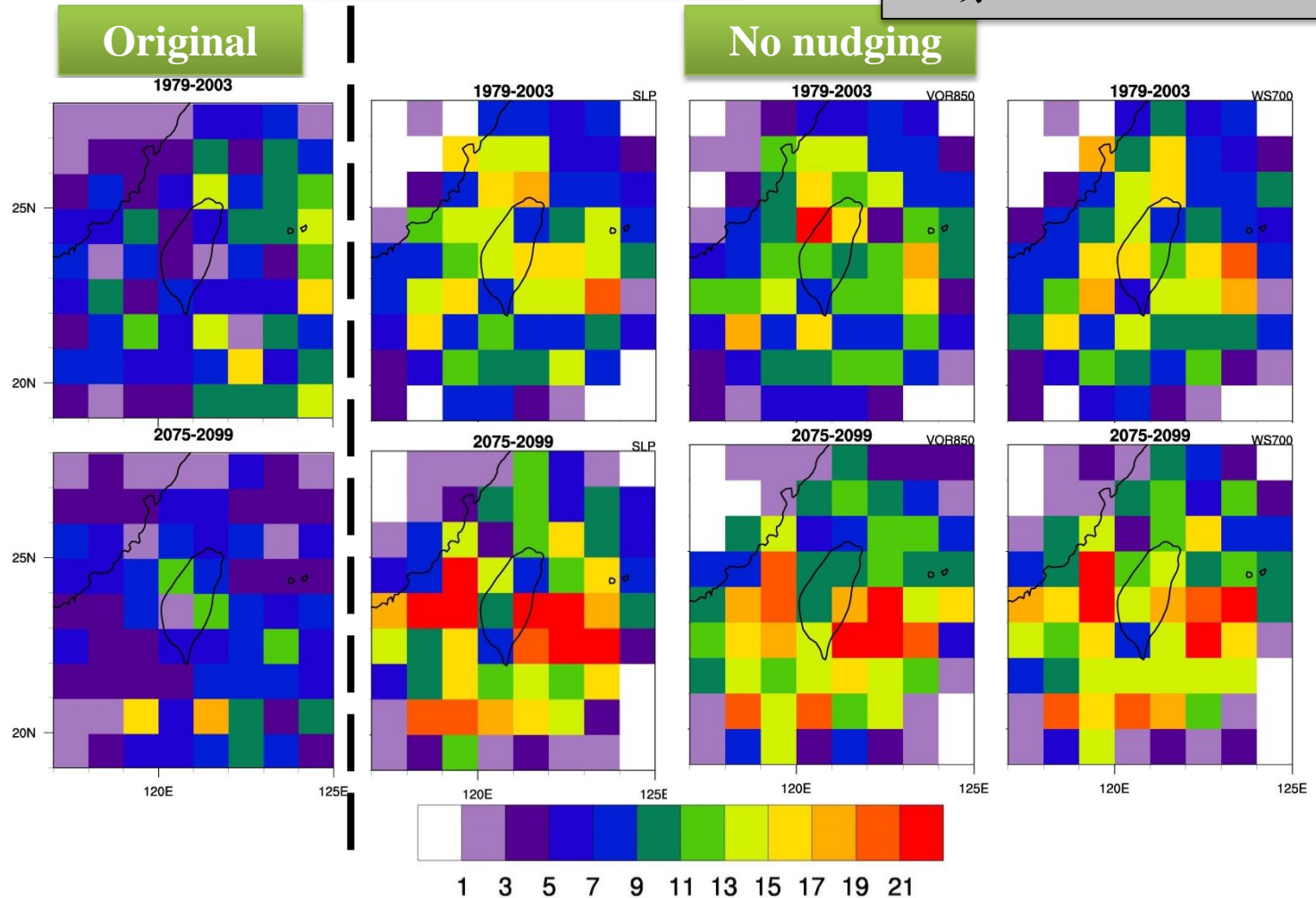
| 時期 | Nudging | | No nudging | |
|-----------|---------------|---------------|---------------|---------------|
| | 侵臺個數 (TYs) | 侵臺時數 (hrs) | 侵臺個數 (TYs) | 侵臺時數 (hrs) |
| 1979-2003 | 58 | 2166 | 76 | 3450 |
| 2075-2099 | 55 | 1854 | 92 | 3888 |

- 侵臺個數、時數增加。
- **降尺度前**資料顯示世紀末登陸個案有**增加**的趨勢，不使用nudging的結果則呈現**些微減少**的趨勢。

Track density

Present day

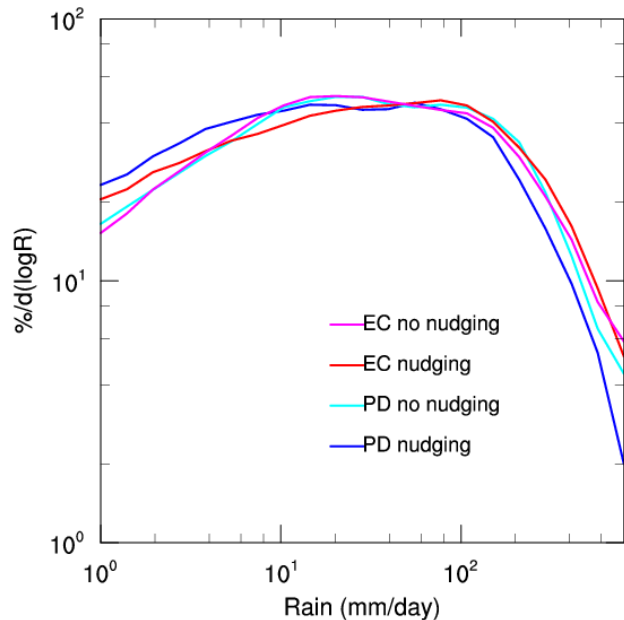
End of century



Precipitation PDF

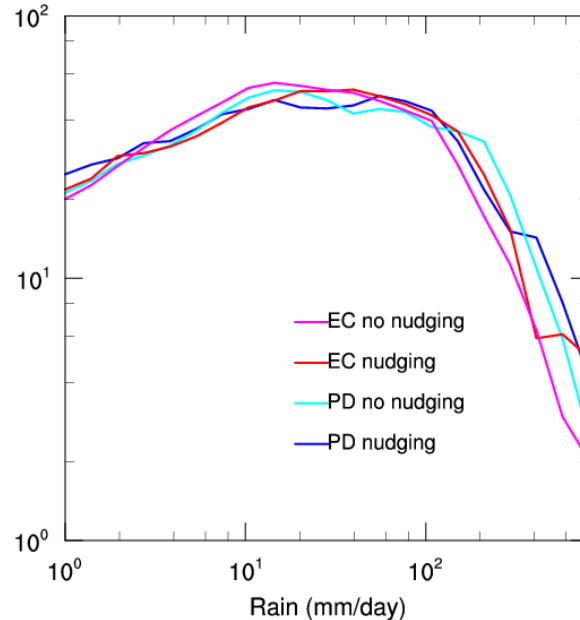
Taiwan

PDF of daily precipitation



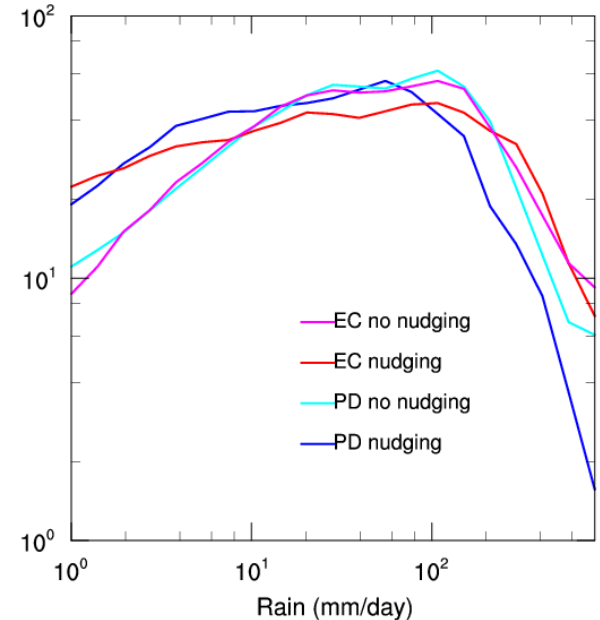
North

PDF of daily precipitation



South

PDF of daily precipitation



- Nudging：弱降雨呈現減少的趨勢；No nudging：弱降雨變化趨勢不明顯。兩者強降雨皆呈現增加的趨勢。
- 沒使用nudging之弱降雨發生頻率減少。

- 有無使用nudging的變化趨勢相似，弱降雨改變趨勢不顯著，強降雨則呈現減少的趨勢。
- 有無使用nudging之降雨頻率差異不大。

- Nudging：呈現弱降雨減少、強降雨增加的趨勢；No nudging：弱降雨變化趨勢不明顯、強降雨些微增加。
- 沒使用nudging之弱降雨發生頻率顯著減少。

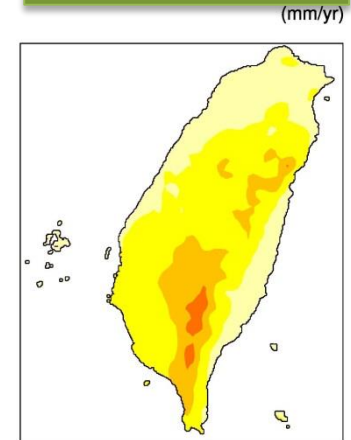
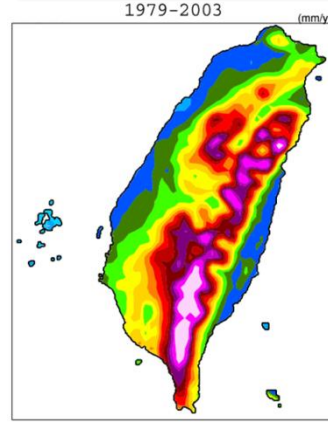
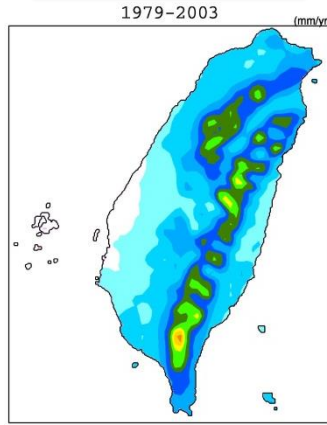
Precipitation

Nudging

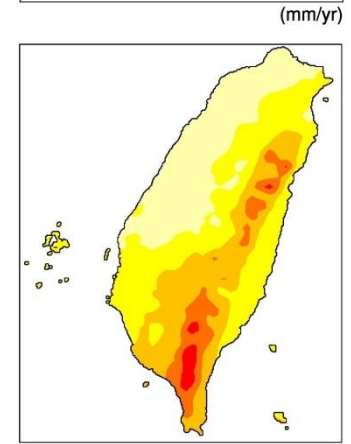
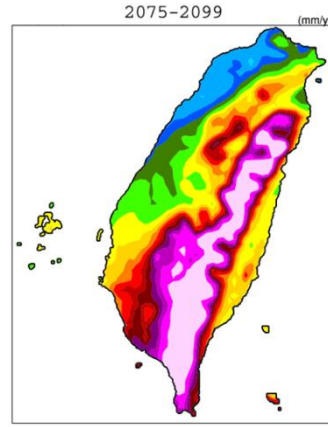
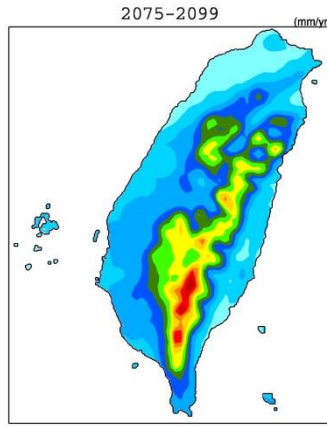
No nudging

Difference

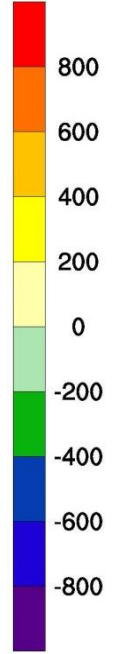
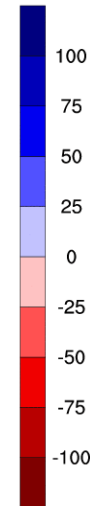
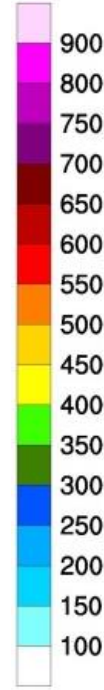
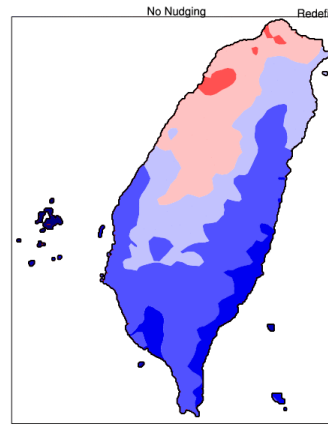
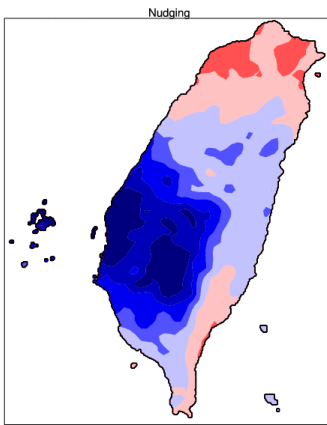
Present day



End of century



Change rate (%)



SDII

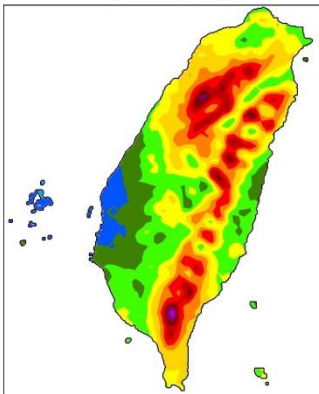
Nudging

No nudging

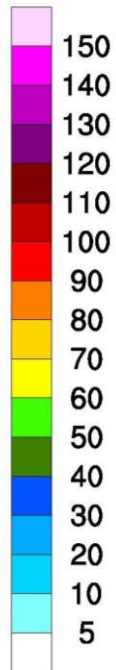
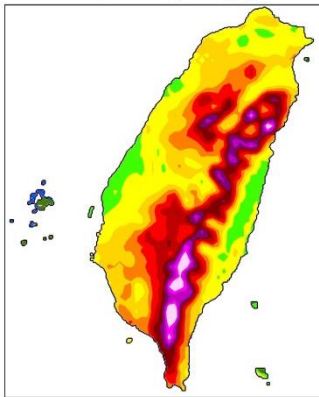
Difference

Present
day

SDII(1979-2003) nudging

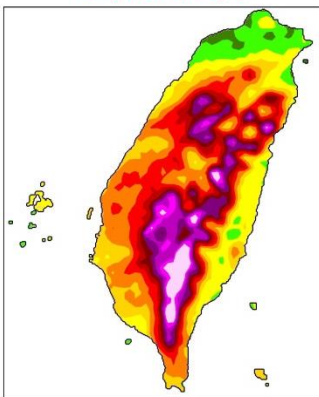


SDII(1979-2003) no nudging

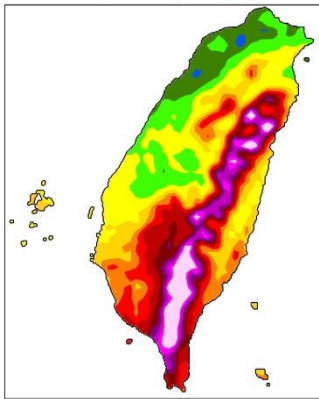


End of
century

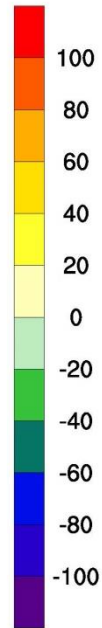
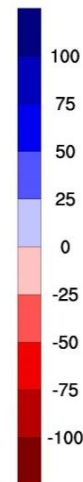
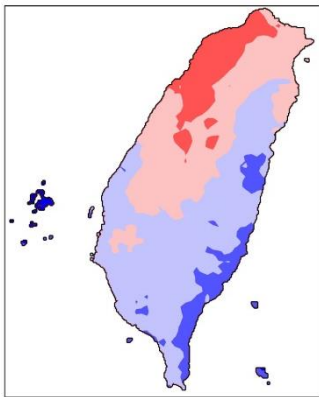
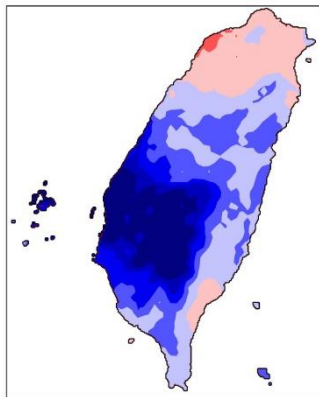
SDII(2075-2099) nudging



SDII(2075-2099) no nudging



Change
rate (%)

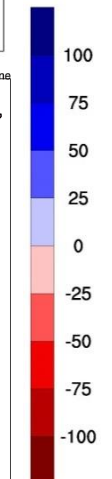
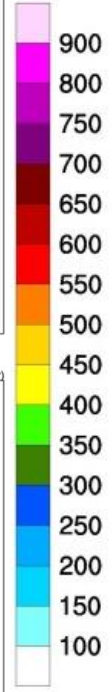
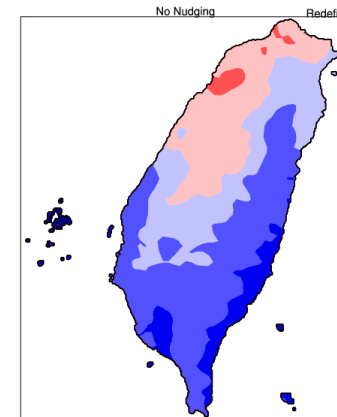
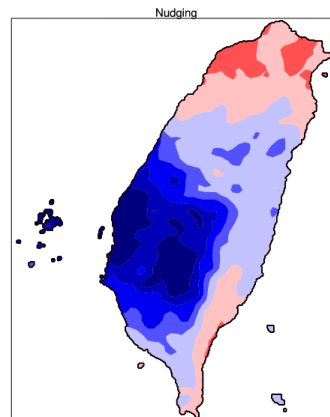
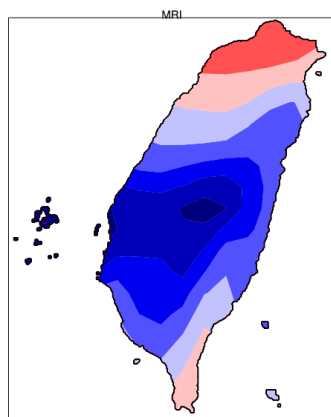
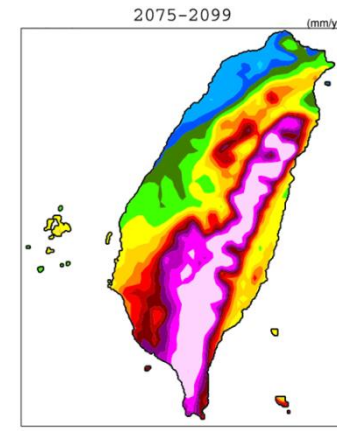
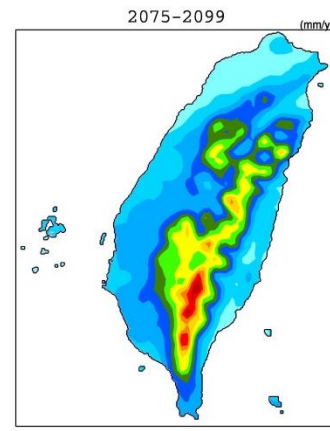
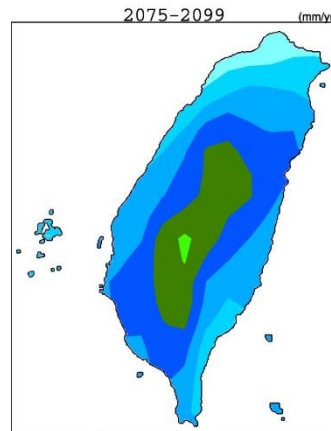
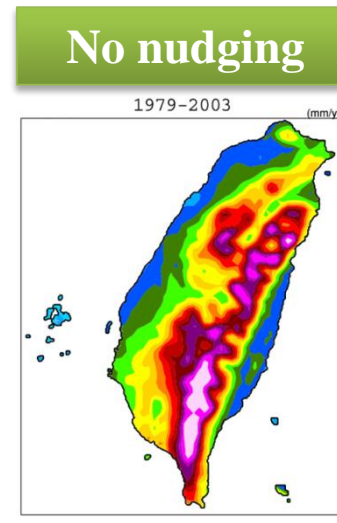
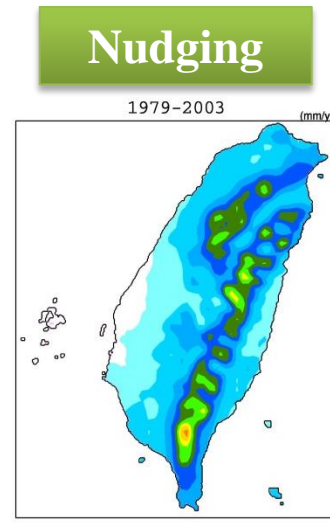
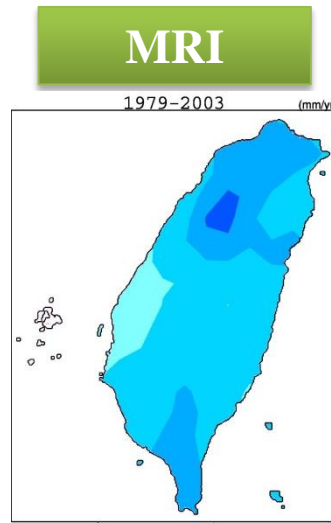


Precipitation

Present day

End of century

Change rate (%)



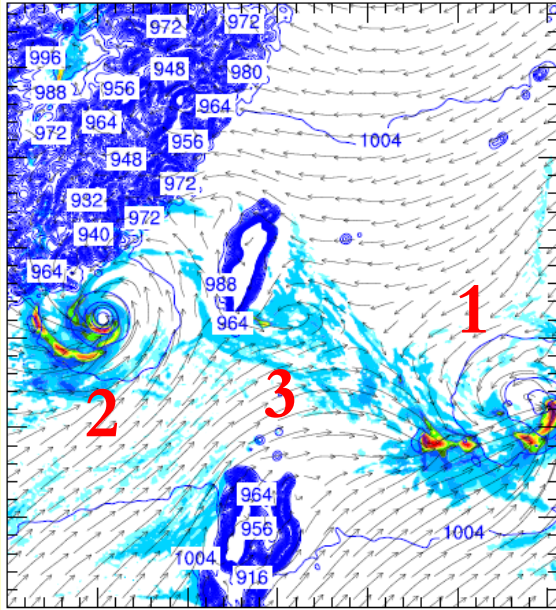
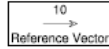
結論與建議

- ❑ 進行降尺度時不使用波譜修正會讓颱風路徑、強度與降尺度前存在相當差異。
- ❑ 初步分析結果顯示不使使用波譜修正進行動力降尺度前相反。世紀末侵臺颱風個數的變化趨勢與降尺度前相反。
- ❑ 臺灣地區較強造成風雨其差變布現的、顯示時因徑沒期可改有兩能變使者是等用存侵原波在臺因譜相颱風修正大個的數。
- ❑ 初步的變、分析結果顯示波勢強，度顯示修正較其他對比較尺不風能度確個夠前定案獲後因在得的素進行降尺時動力降尺前減少。

1982-08-09_18:00:00-1982-08-09_19:00:00

Case 1

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)

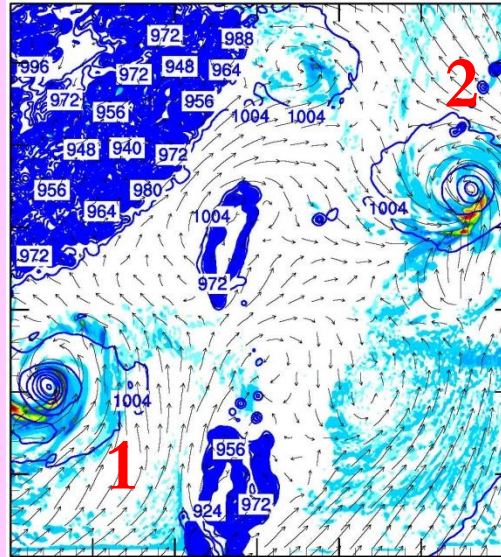
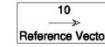


Case 2

2003-08-14_00:00:00-2003-08-14_01:00:00

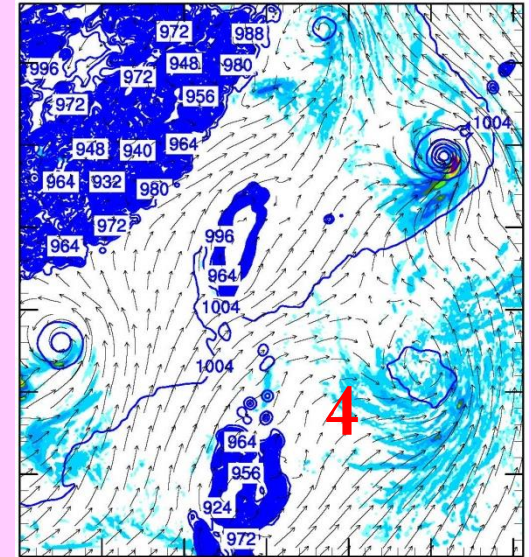
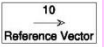
SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)

3

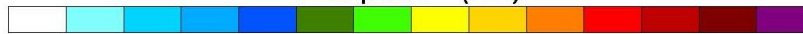


2003-08-14_18:00:00-2003-08-14_19:00:00

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)



Precipitation (mm)

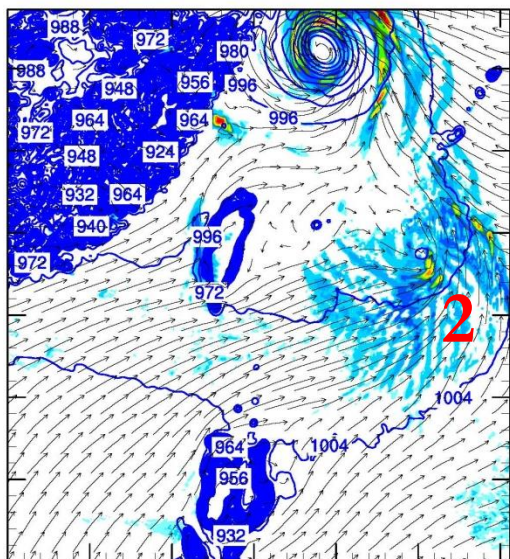


1 2 6 10 15 20 30 40 50 70 90 110 130

2095-07-23_12:00:00-2095-07-23_13:00:00

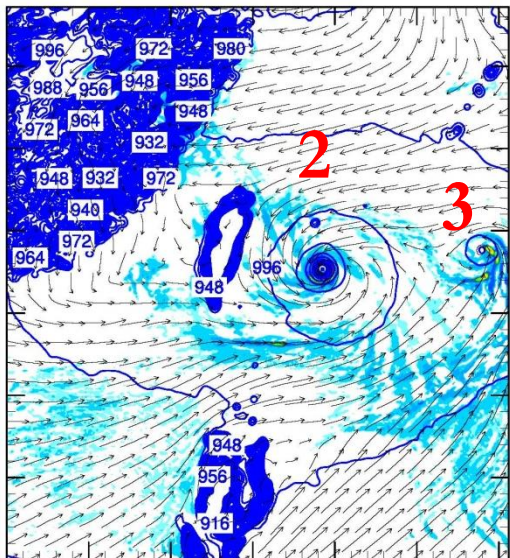
Case 3

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)



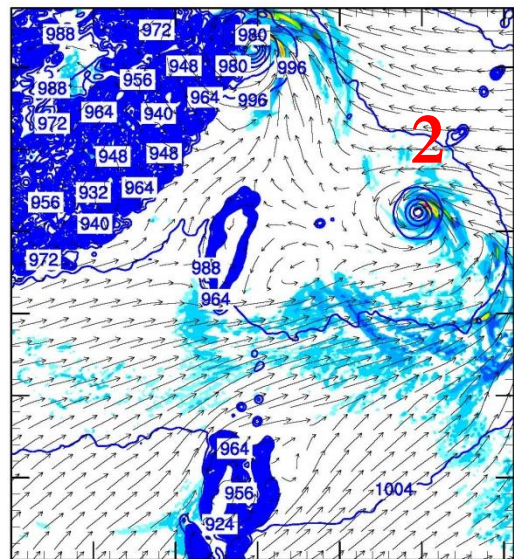
2095-07-25_18:00:00-2095-07-25_19:00:00

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)



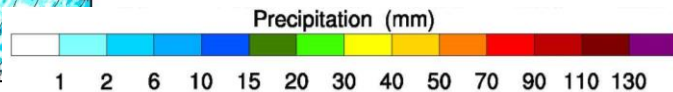
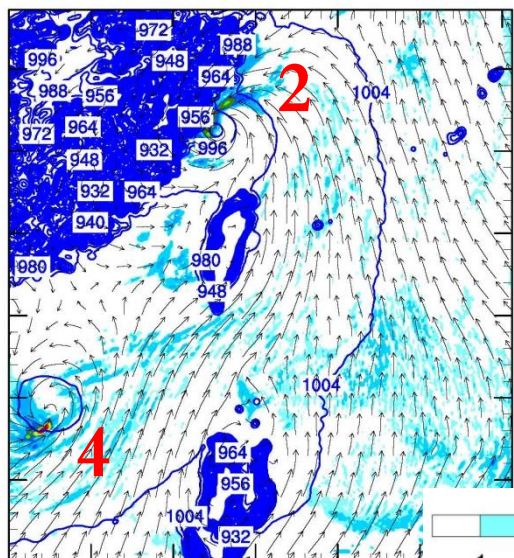
2095-07-24_12:00:00-2095-07-24_13:00:00

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)



2095-07-28_18:00:00-2095-07-28_19:00:00

SFC PRESSURE (Pa)
Precipitation (mm)
Wind (m/s)

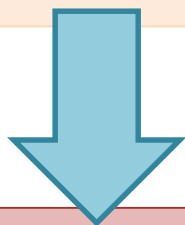


未來工作

高解析度(5km)模式能夠模擬出小尺度之系統(擾動)



使用與MRI-AGCM (20km)同樣之門檻值偵測颱風，
造成颱風個數高估？



調整偵測颱風之門檻值

簡報完畢
謝謝