

氣候變遷模擬與推估

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人為氣候變遷專題中心

中研院環境變遷研究中心



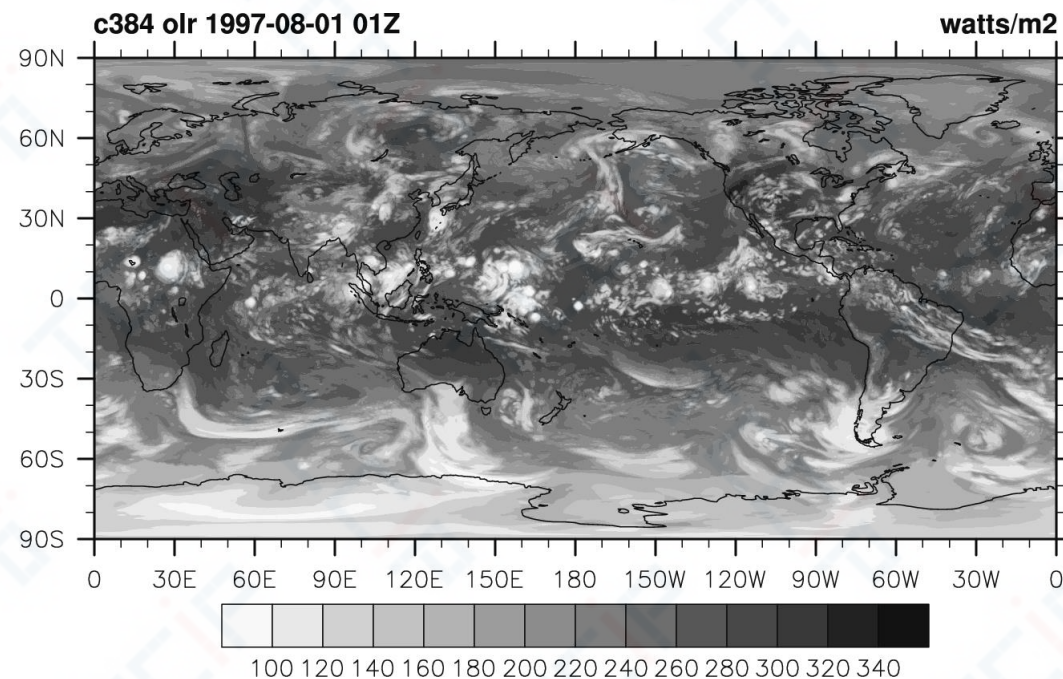
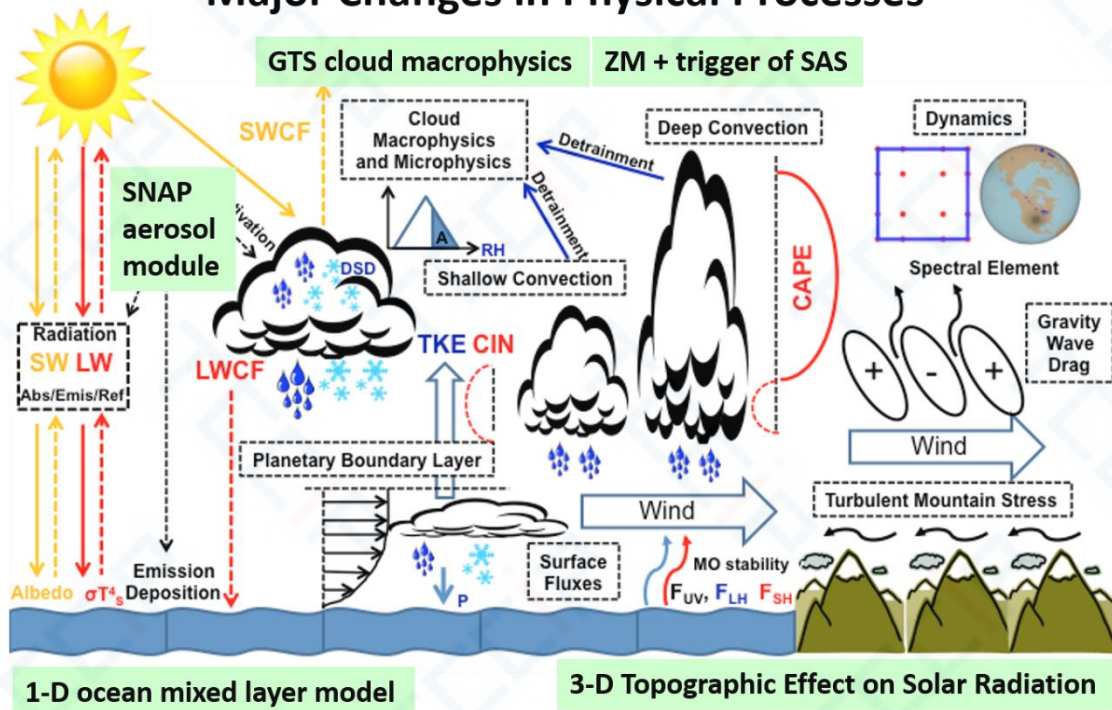
台灣地球系統模式

Taiwan Earth System Model
(100 km, 發展中: 25/50 km)

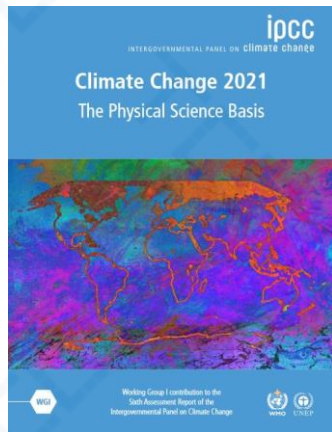
可解析颱風的全球大氣模式

TC-resolving HiRAM/HiRAM-SIT
(GFDL; 25/50 km)

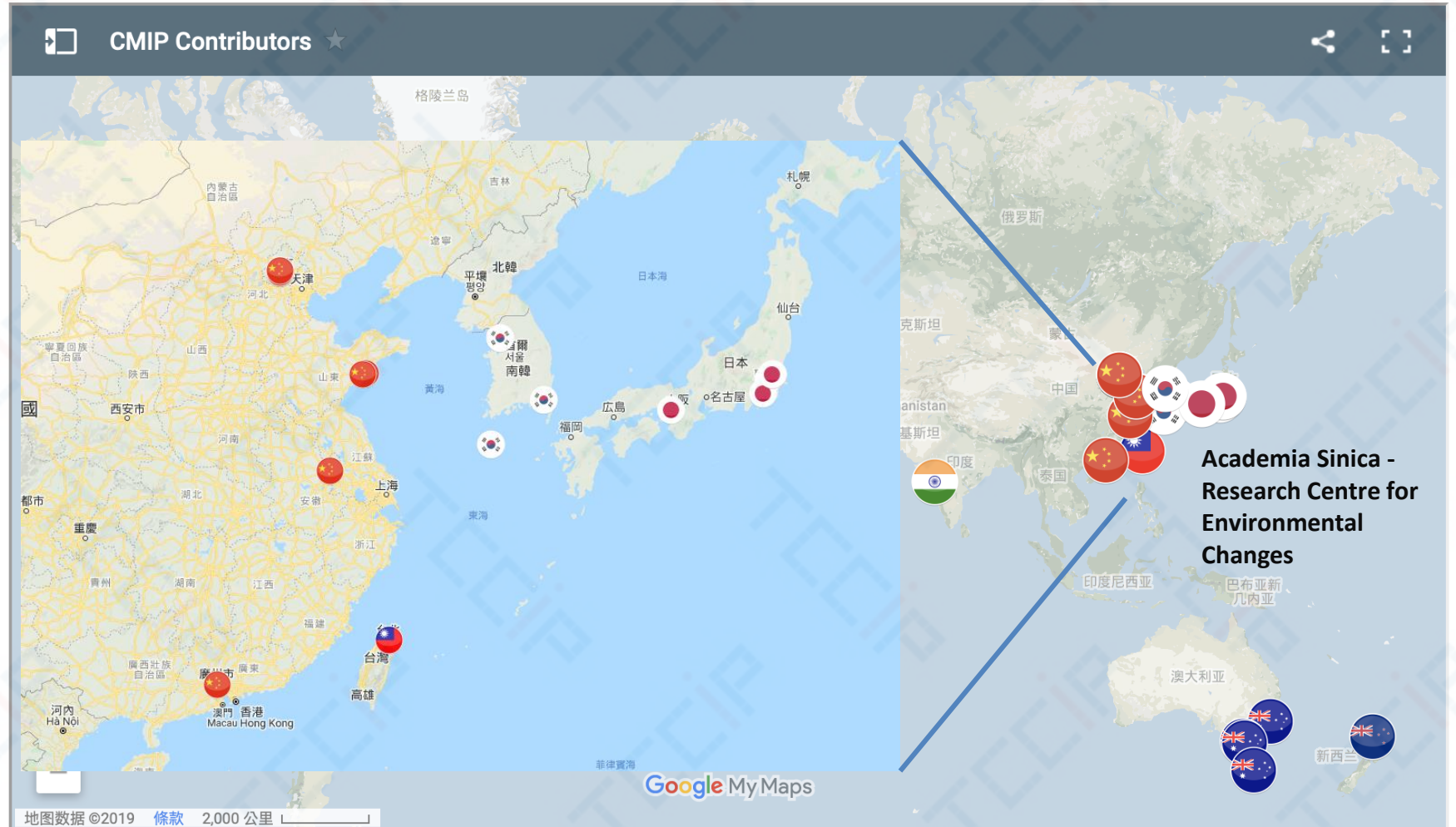
TaiESM1 based on CESM1.2.2
Major Changes in Physical Processes



以台灣為名參加第六期耦合模式比對計畫(CMIP6)

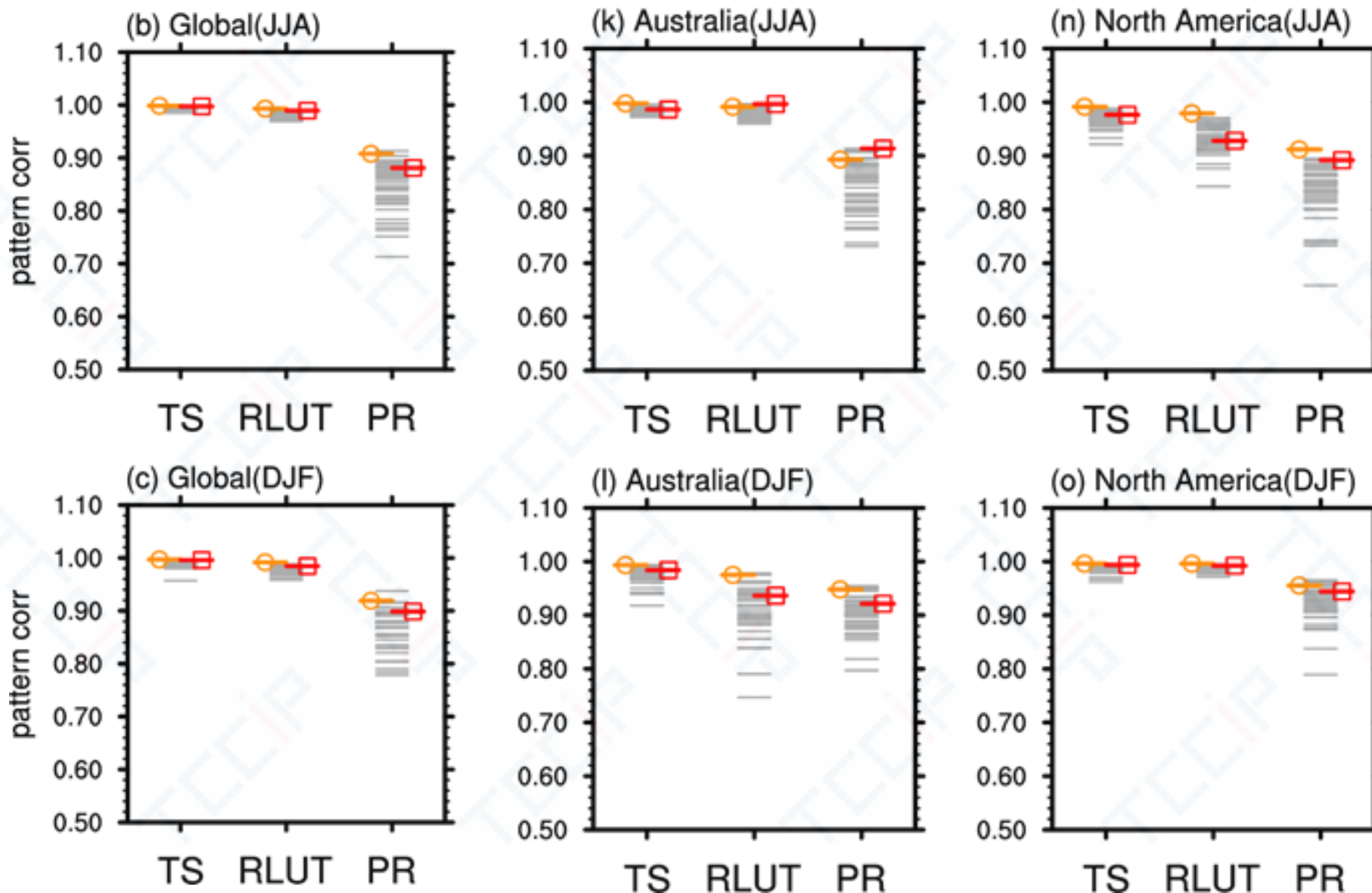


CMIP6 Modeling Groups (click on flags to reveal identity)

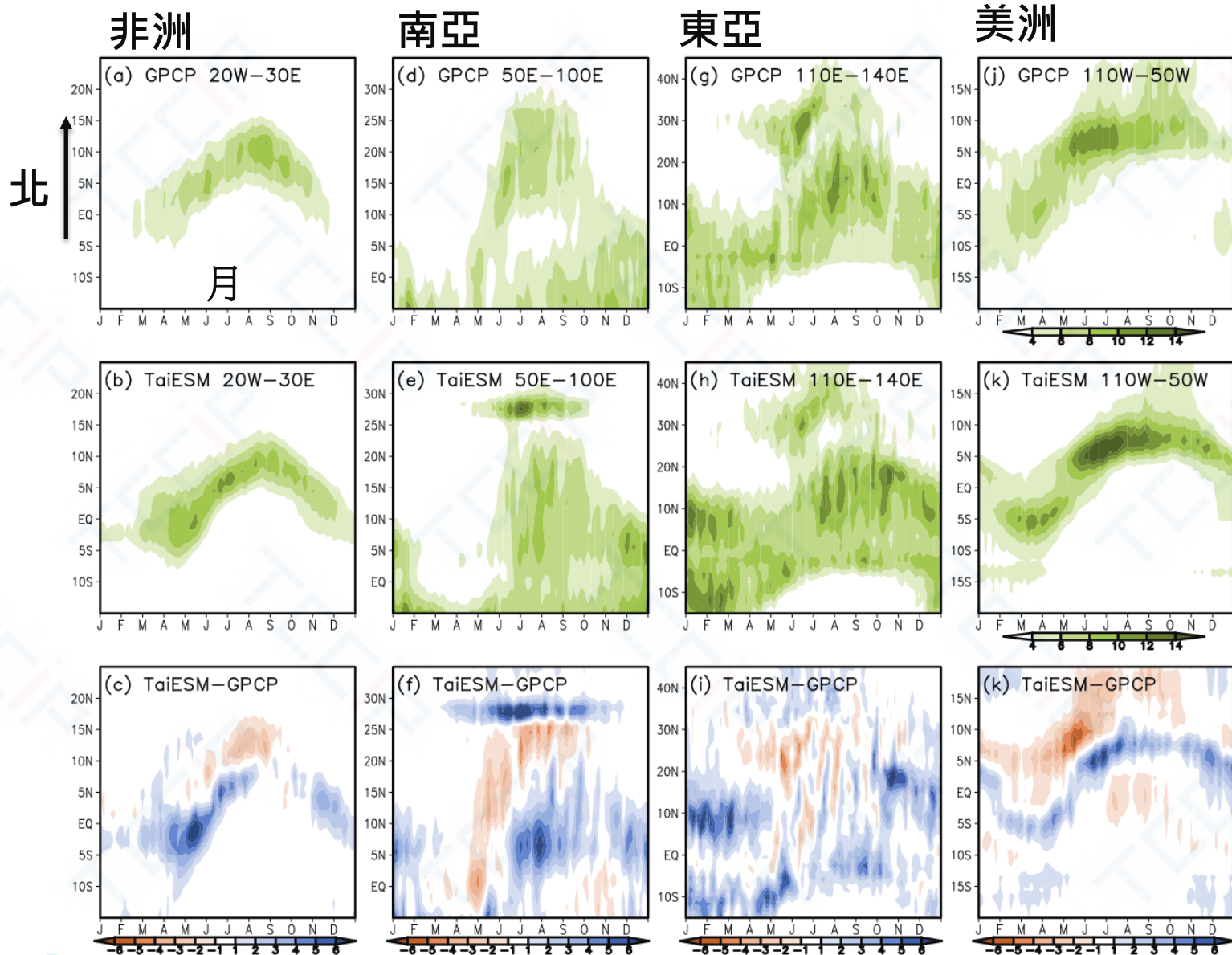


模式表現評估: 地表溫度(TS), 輻射(RLUT), 降水(PR)

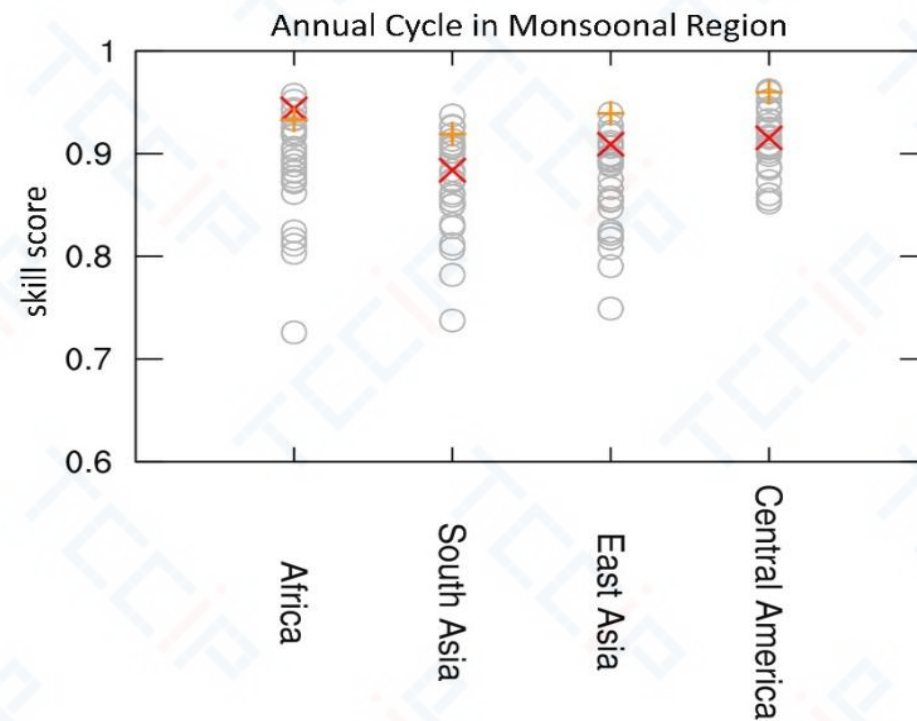
TaiESM1 (red) vs CMIP6 models (grey)/ensemble means (orange)



模式表現評估: 四大季風區季節降雨

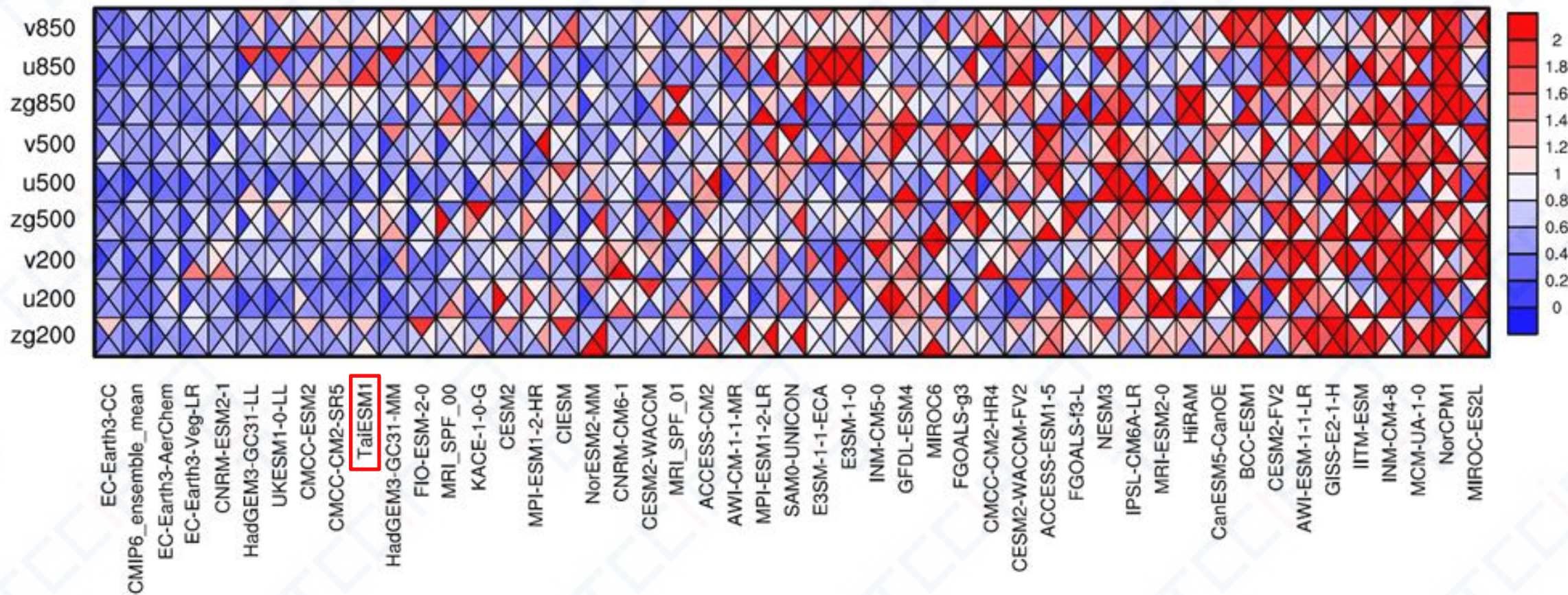


Skill Score (技術得分) CMIP6 Models



(Taylor, 2001)

模式表現評估: 東亞地區(10N~50N ; 100E~145E , 1985-2014)

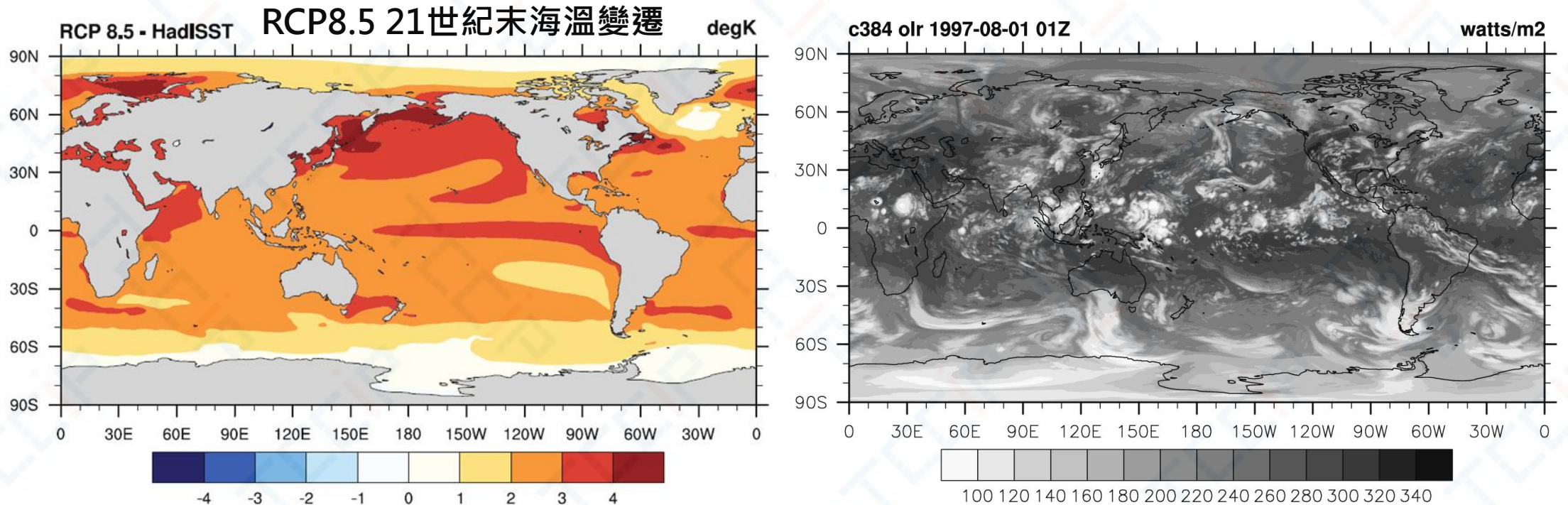


高解析(極端天氣)氣候模擬與推估

HiRAM/GFDL: 1979-2008, 2036-2060, 2075-2100 (RCP8.5), 25 and 50 km

Observed SST + Deviation of Ensemble-mean SST (RCP8.5) from present

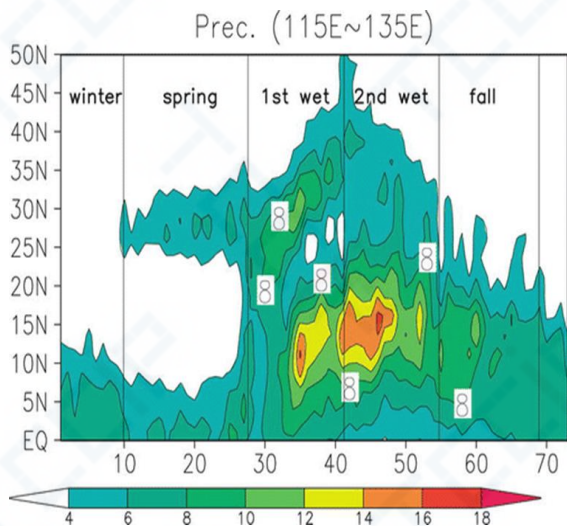
以未來海溫變遷驅動全球大氣模式



東亞降雨年循環

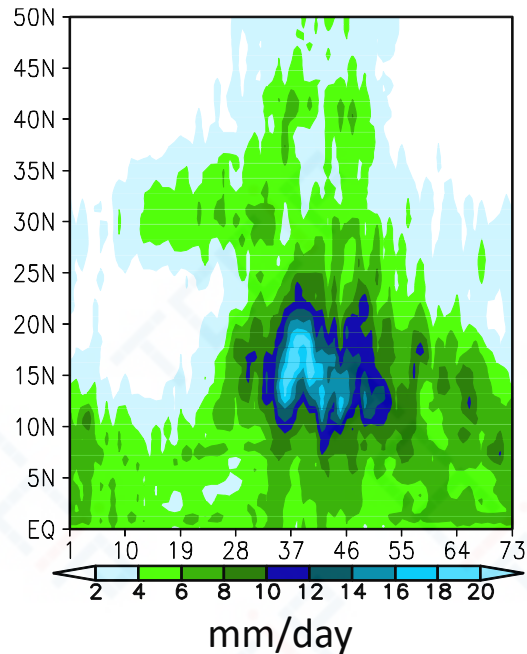
115°E-135°E

HiRAM_c192_amip_06

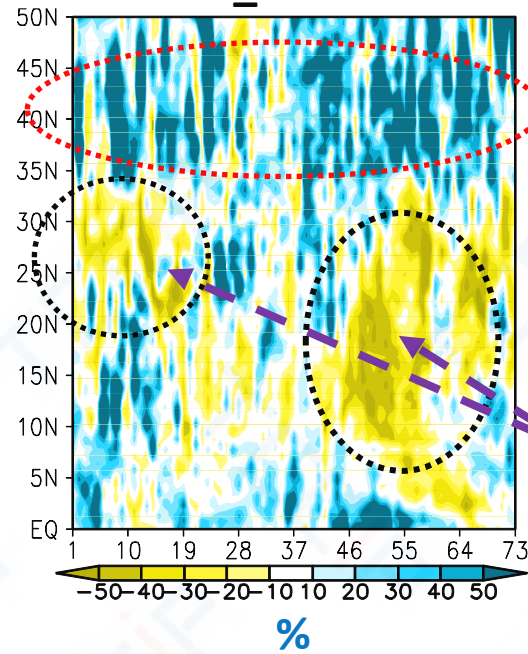


Difference in seasonal precipitation climatology between **ensemble/C1/C2/C3** and **Present AMIP** experiments.

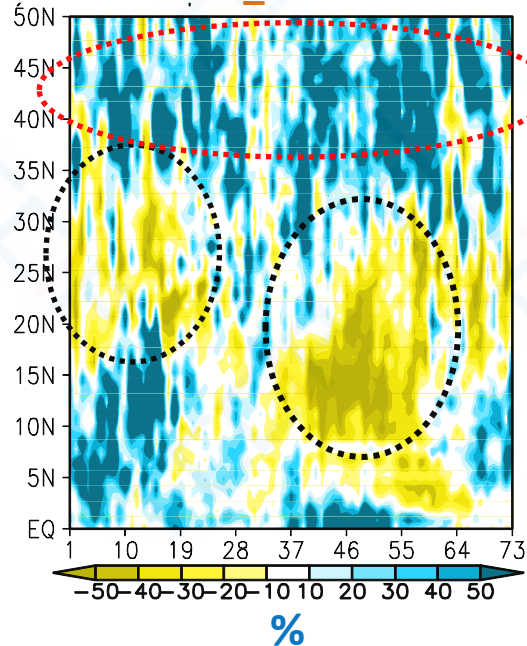
Present



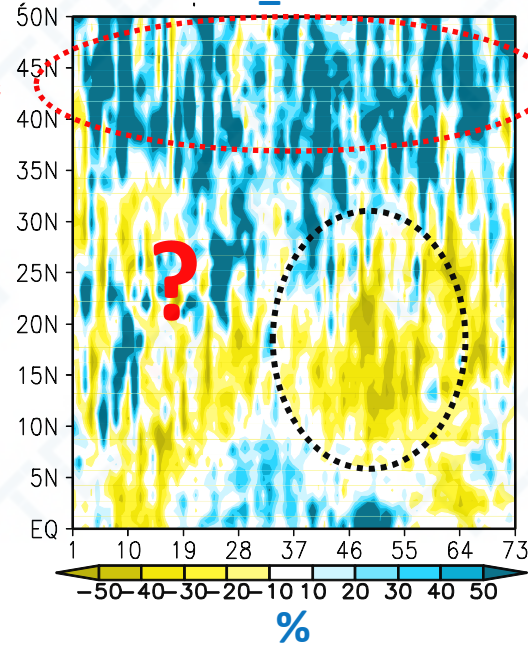
RCP85_ens—AMIP



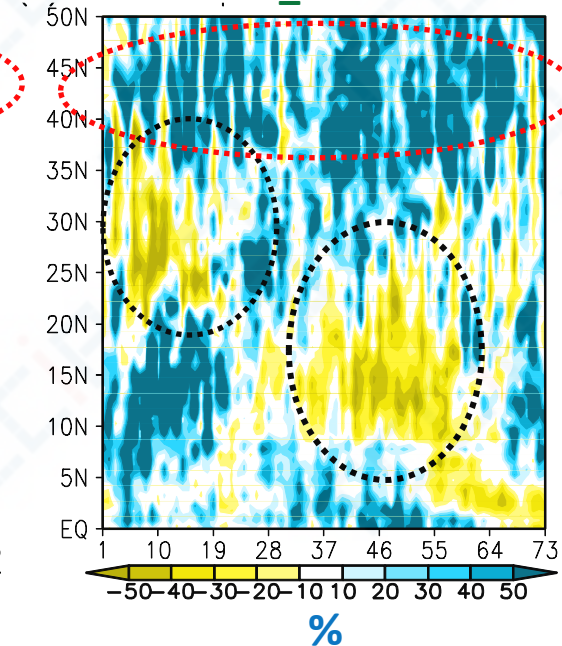
RCP85_C1 —AMIP



RCP85_C2 —AMIP



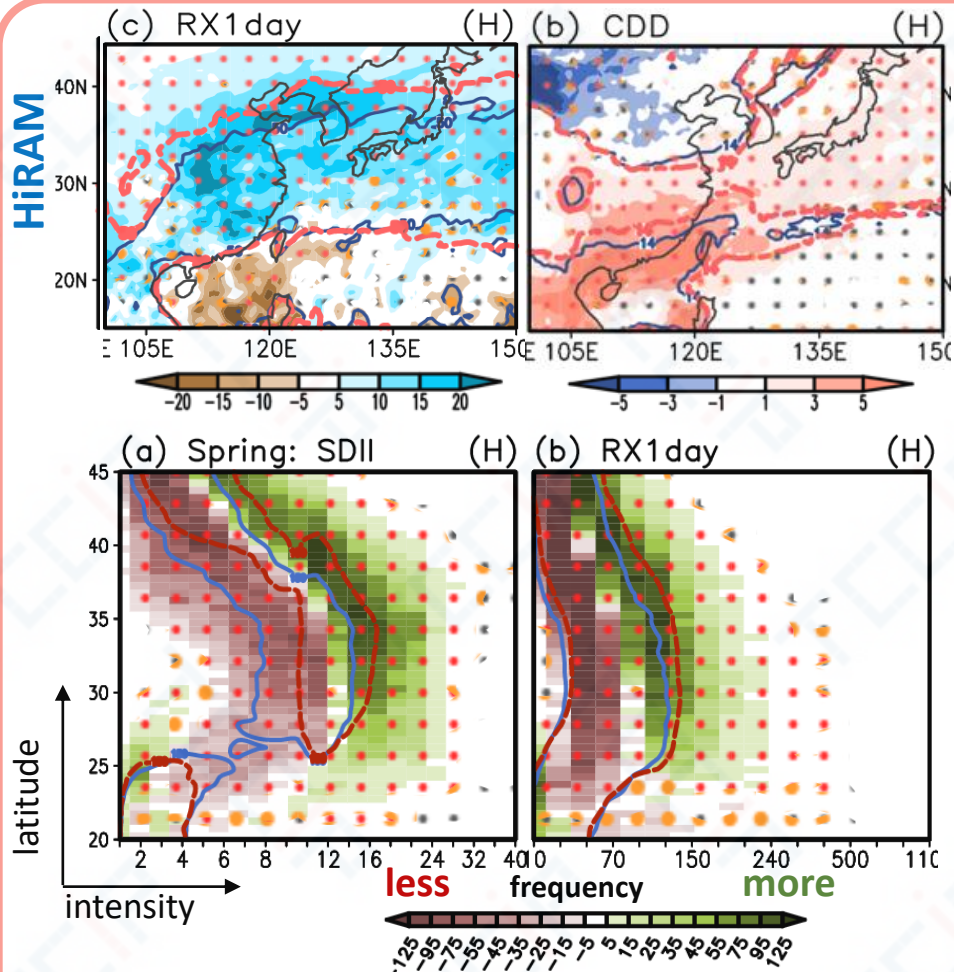
RCP85_C3 —AMIP



東亞春季與梅雨季極端降雨變遷

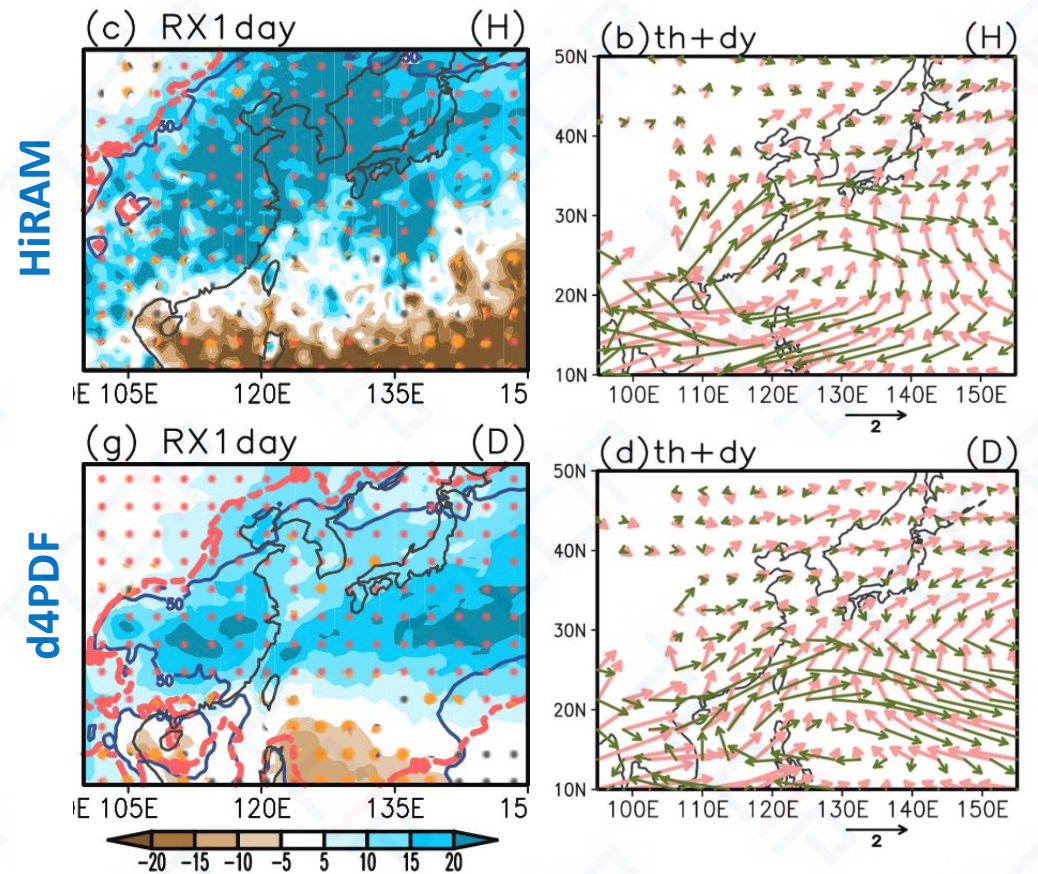
Chen, et al. (2022), *Weather and Climate Extremes*, <https://doi.org/10.1016/j.wace.2022.100408>

春雨



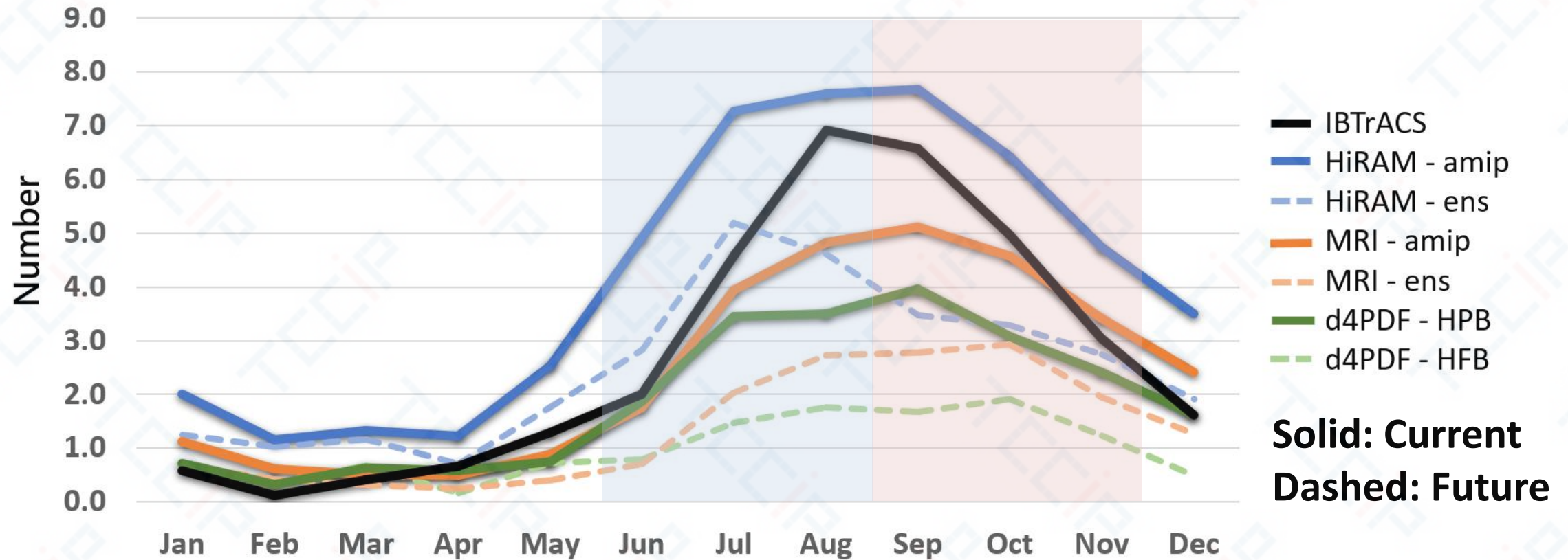
- 極端降雨北移且加強，更頻繁發生
- 整體降雨日數減少，連續乾日變長
- 台灣發生乾旱機率增加

梅雨



- 副熱帶高壓變強，西南氣流變強，往北傳送更多水氣
- 極端降雨變頻繁且增強

西北太平洋颱風將明顯減少: HiRAM, MRI-AGCM, d4PDF



HiRAM, MRI-AGCM: Same SSTA
MRI-AGCM, d4PDF: Same model, different SSTA



database for Policy Decision making
for Future climate change (d4PDF)
MRI-AGCM forced by six SST changes,
100 members (present), **90** members (future)

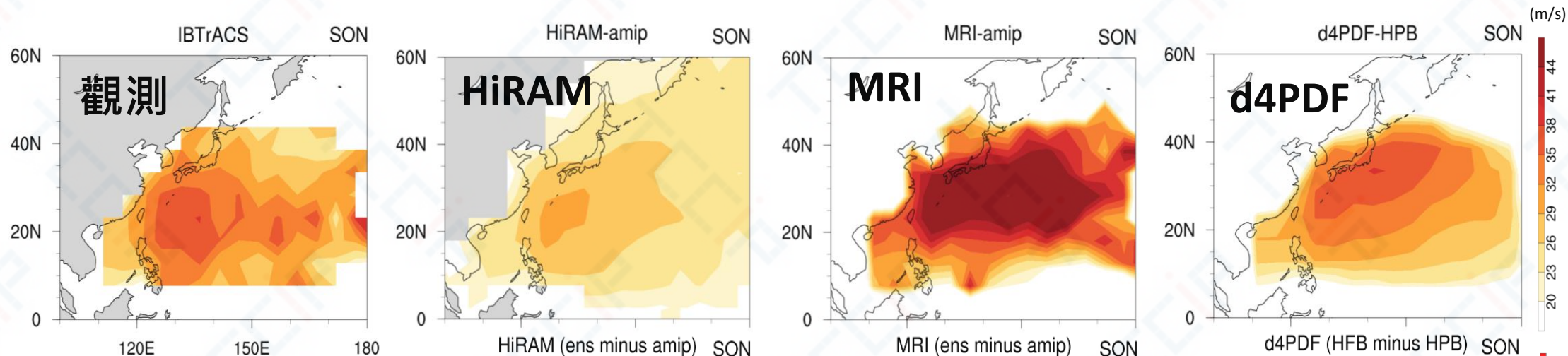
西北太平洋颱風將**明顯減少**: **HiRAM**, **MRI-AGCM**, **d4PDF**

Consistent Results: Different models, different SSTs

	JJA				SON			
	1979-2008	2075-2100	Change	% Change	1979-2008	2075-2100	Change	% Change
IBTrACS	13.5				14.6			
HiRAM	19.8	12.7	-7.1	-36%	18.8	9.5	-9.3	-49%
MRI	8.8	4.0	-4.8	-54%	9.5	4.8	-4.7	-49%
d4PDF	10.5	5.5	-5	-48%	13.1	7.7	-5.4	-41%

颱風強度變遷: 北方增強, 南方減弱

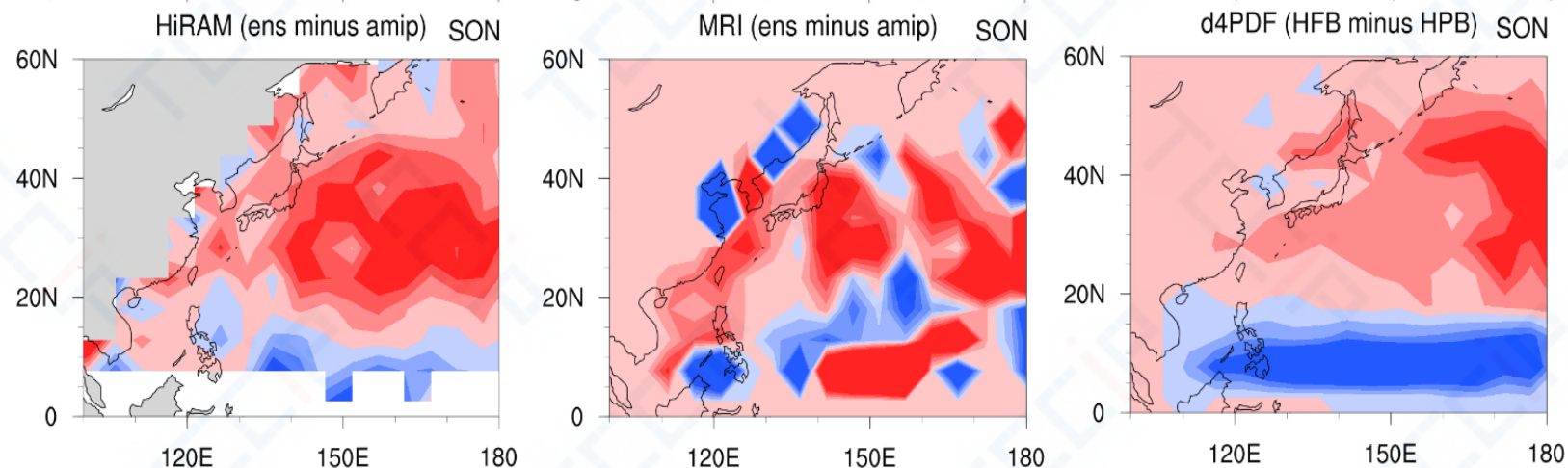
現今



未來變遷

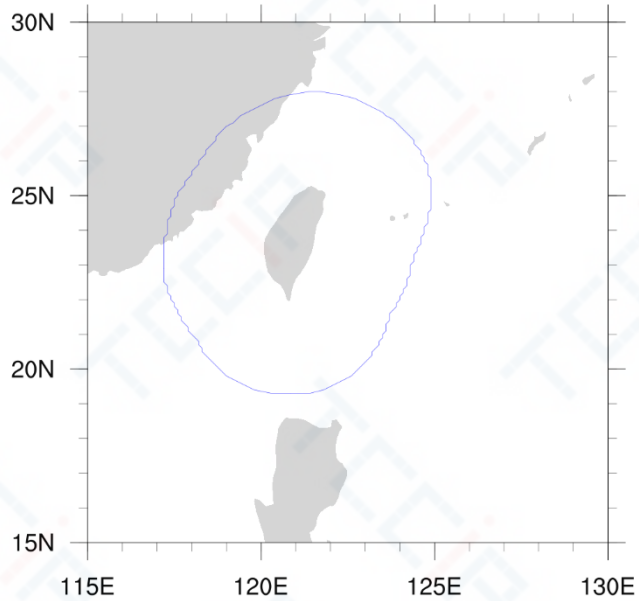
北:增強

南:減弱



侵台颱風個數近未來變遷 (CMIP6/HiRESMIP; 2030-2050): **減少趨勢**

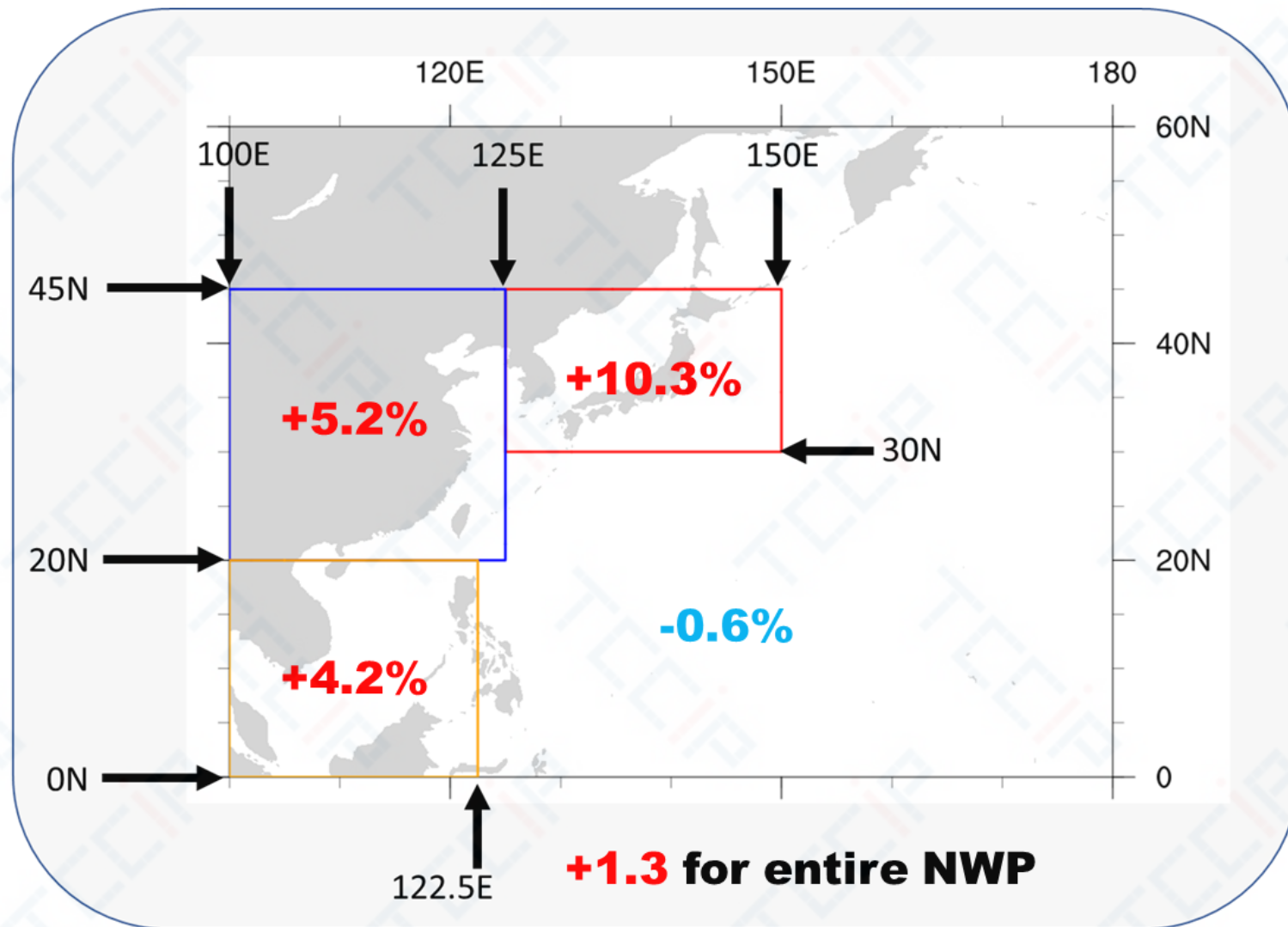
Number of cyclone
pass through
300km boundary



減少 11.6%

Model (AGCM)	Res.	Number of TC approaching (/year)			T-test
		Present (1994-2014)	Future (2030-2050)		
IBTrACS		5.9	-		
HadGEM3-GC31-MM	100	6.3	4.9	(-22.2%)	95 %
HadGEM3-GC31-HM	50	6.2	6.3	(+1.6%)	5 %
MPI-ESM1-2-HR	100	0.3	0.2	(-33.3%)	85 %
MPI-ESM1-2-XR	50	0.3	0.3	(+0%)	0 %
EC-Earth3P	100	1.1	0.9	(-18.2%)	44 %
EC-Earth3P-HR	50	2.1	2.5	(+19%)	58 %
HiRAM-c192	50	9.3	7.7	(-17.2%)	93 %
HiRAM-c384	25	6.7	4.7	(-29.9%)	99 %
CESM1-CAM5-SE-LR	100	0.8	0.9	(+12.5%)	47 %
CESM1-CAM5-SE-HR	25	4.6	4.6	(+0%)	7 %
MRI-AGCM3_60km	60	3.1	2.2	(-29%)	88 %
MRI-AGCM3_20km	20	4.1	4	(-2.4%)	14 %
NICAM_56km	56	9.1	8.4	(-7.7%)	55 %
NICAM_28km	28	6.8	5.8	(-14.7%)	76 %
Ensemble - LR	≈100km	2.1	1.7	(-19%)	95 %
Ensemble - MR	≈50km	5	4.6	(-8%)	82 %
Ensemble - HR	≈25km	5.5	4.8	(-12.7%)	97 %
Total Ensemble		4.3	3.8	(-11.6%)	99 %

颱風降雨量在近未來的變遷: 雨量增加趨勢



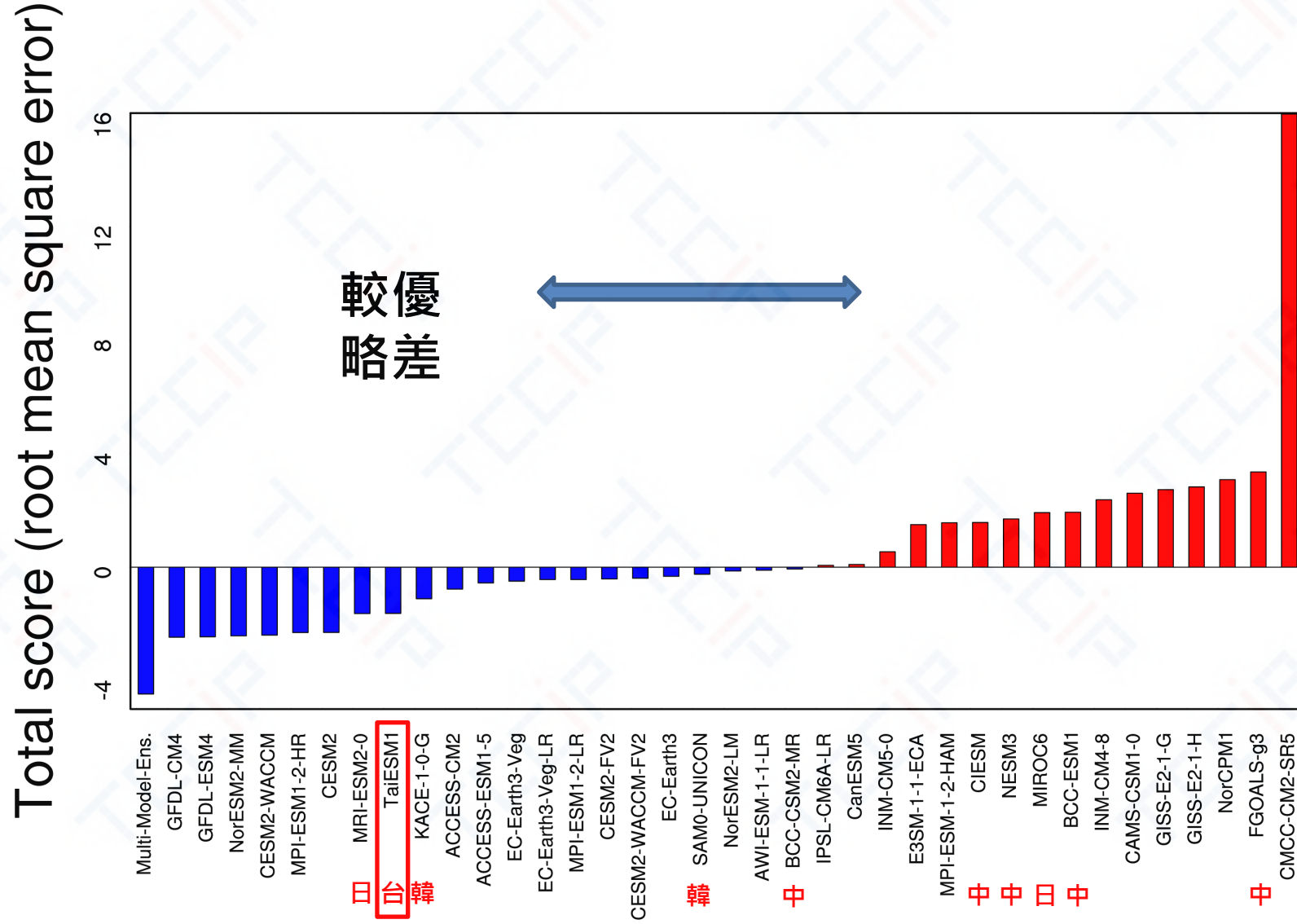
颱風100公里半徑內

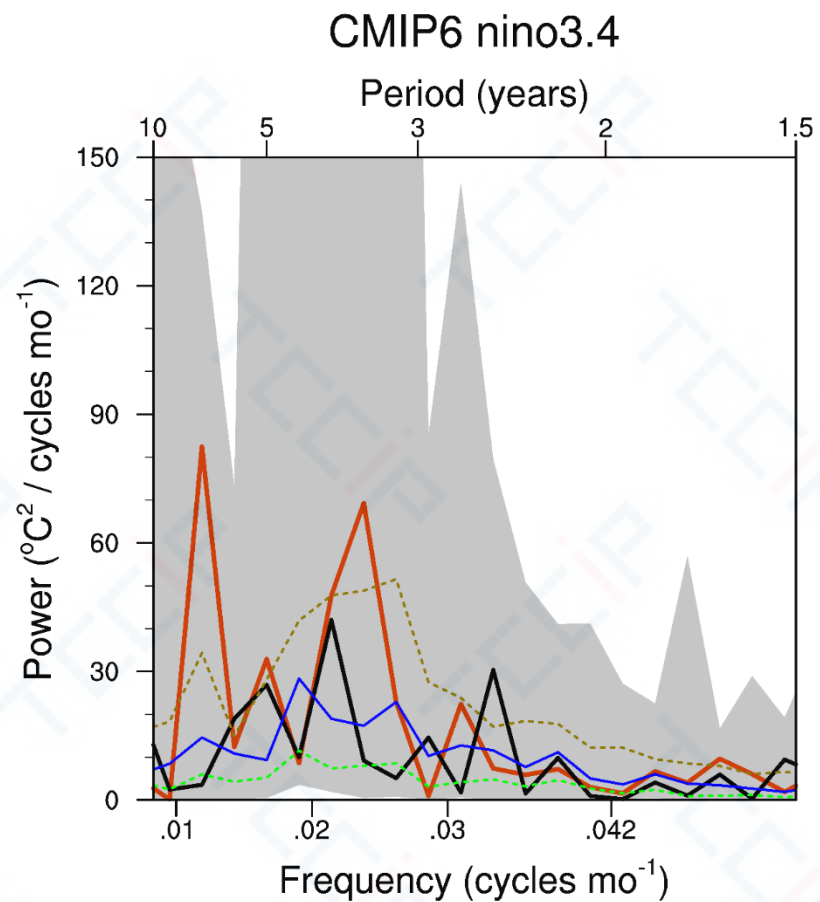
謝謝聆聽



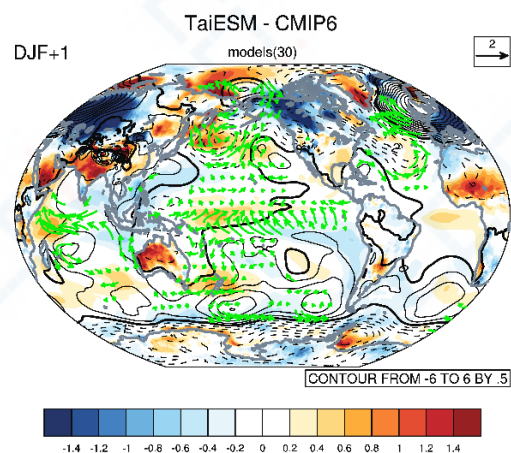
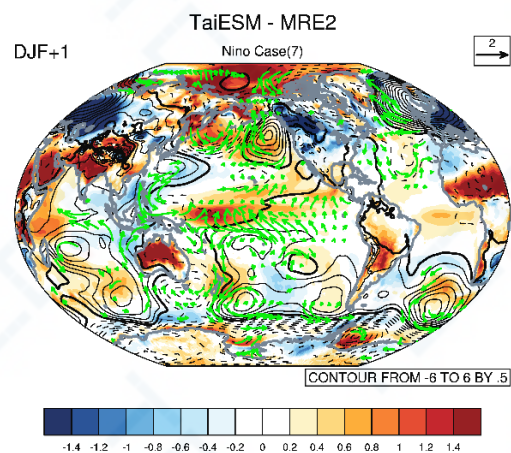
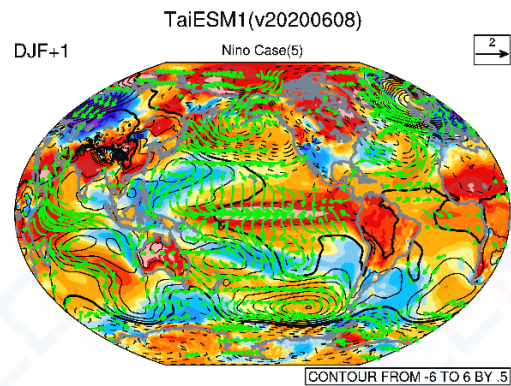
台灣地球系統模式

與日本氣象廳模式相當，表現優於亞洲(韓國、中國)其他模式



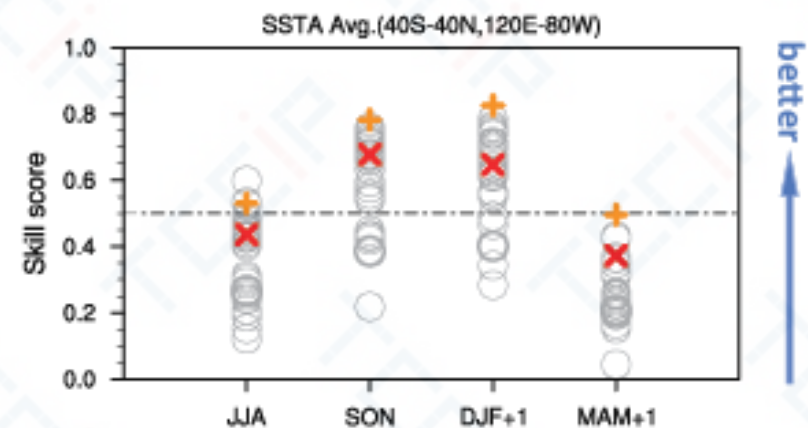


- ERSST
- TaiESM
- ⋯ 25%
- median
- ⋯ 75%



聖嬰/反聖嬰

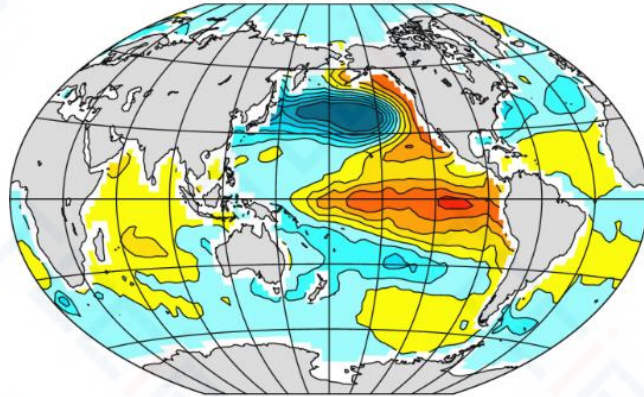
(c) Ranking with SSTA skill score



Inter-annual and Inter-decadal Oscillations

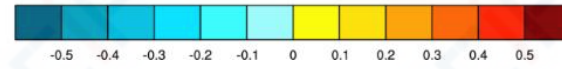
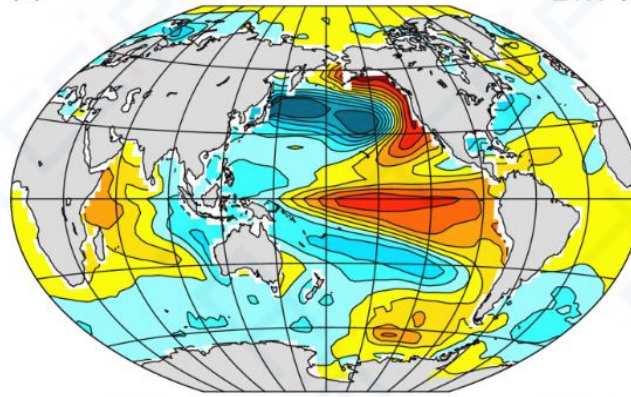
(a) HadISST PDO

28.4%

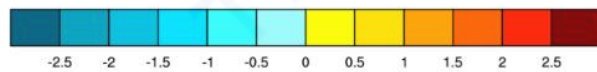
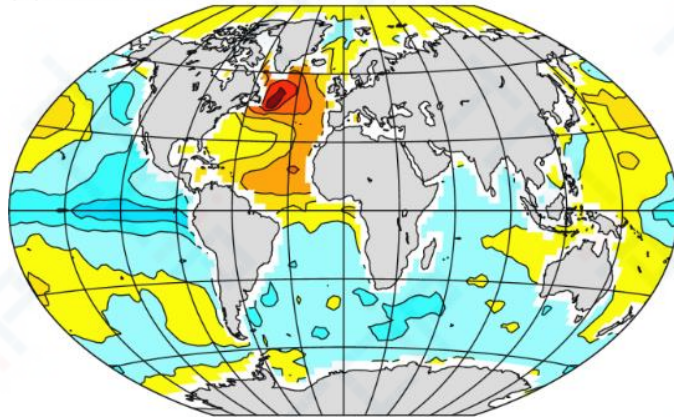


(b) TaiESM PDO

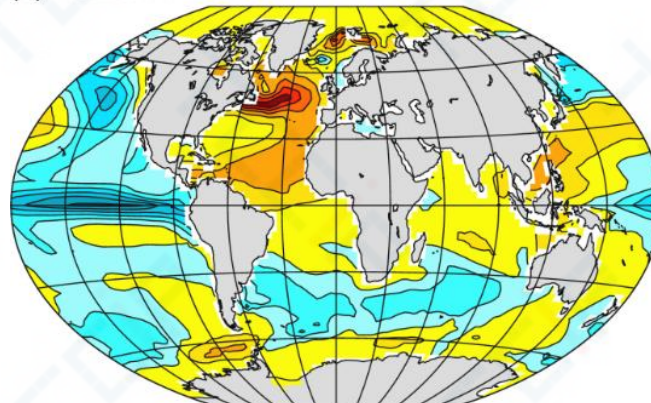
21.1%



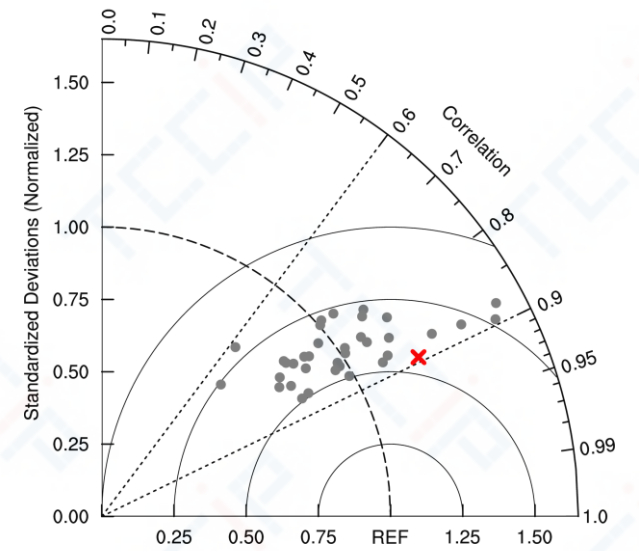
(d) HadISST AMO



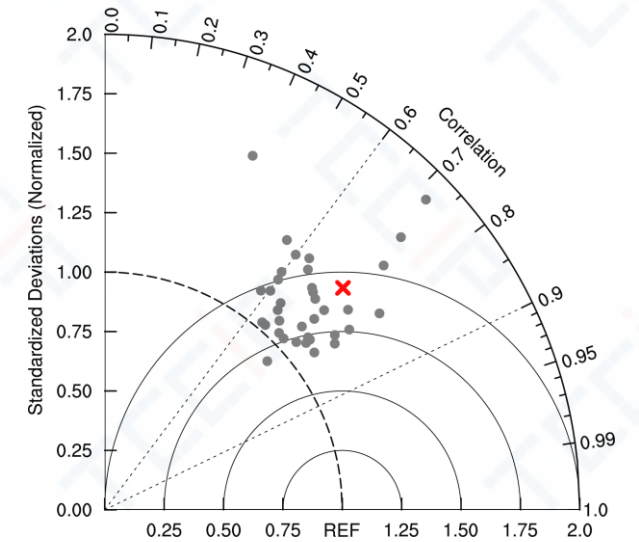
(e) TaiESM AMO



(c) CBF PDO (mon), Taylor diag (sst)

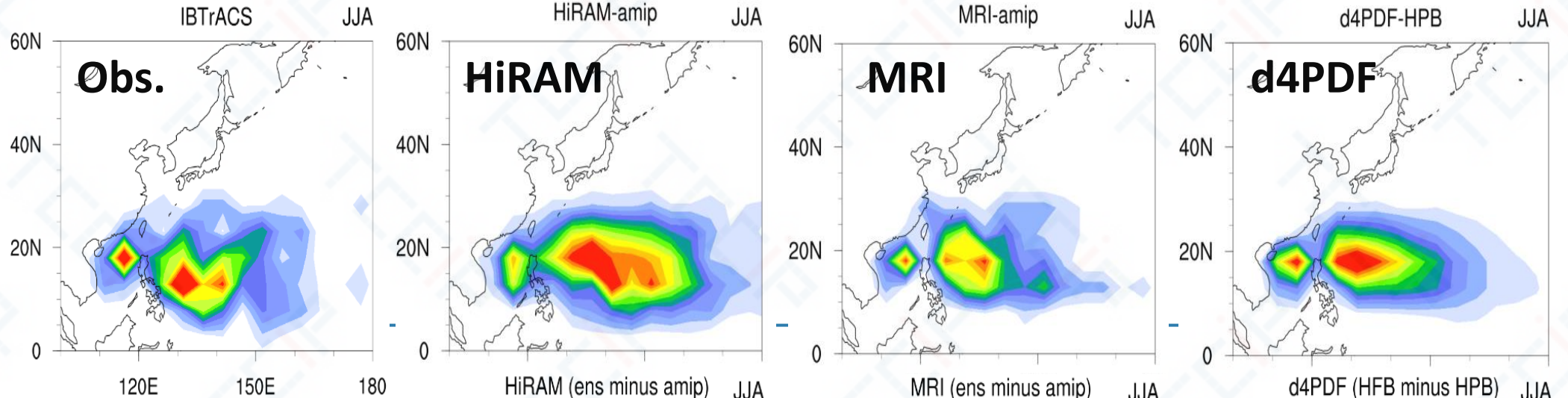


(f) AMO (mon), Taylor diag (sst)

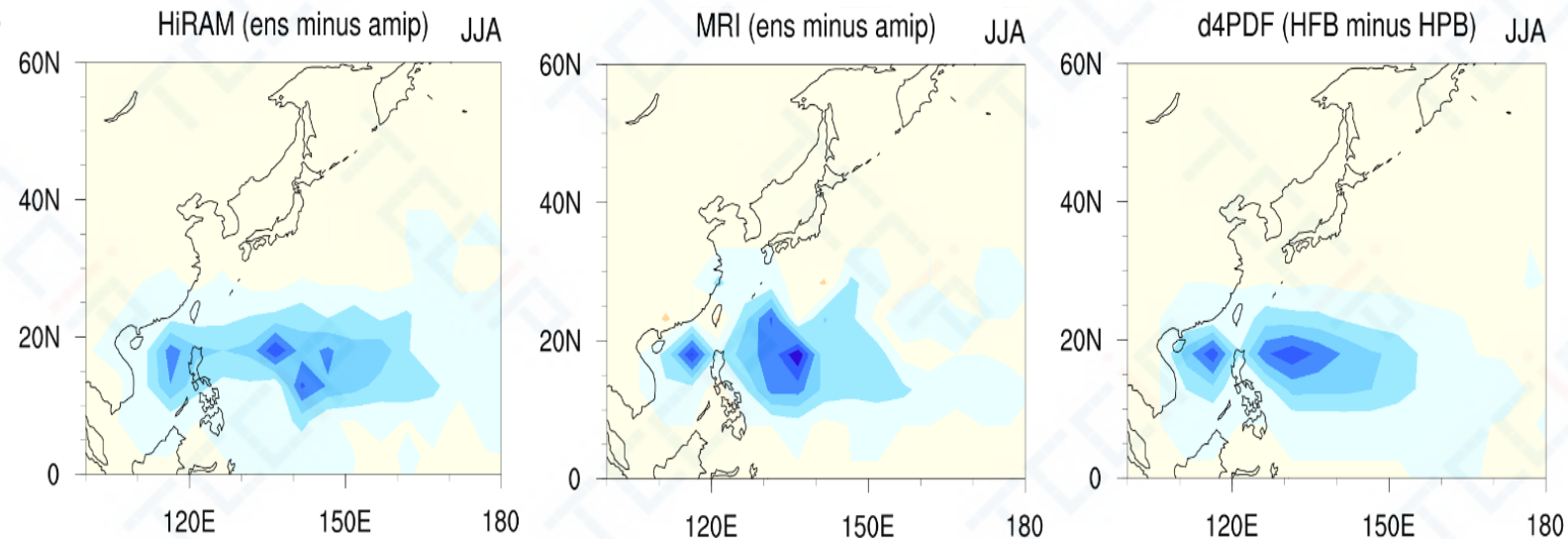


TC Genesis Summer

Present



Future Change:
Significant Reduction

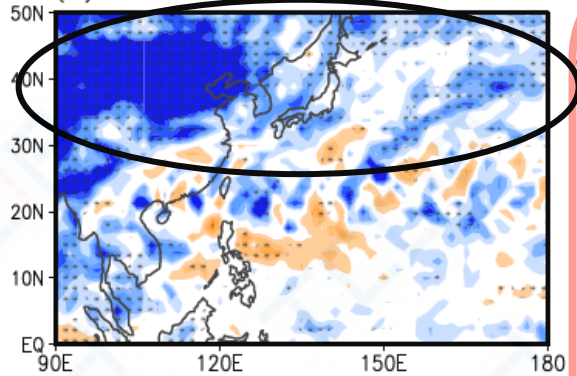
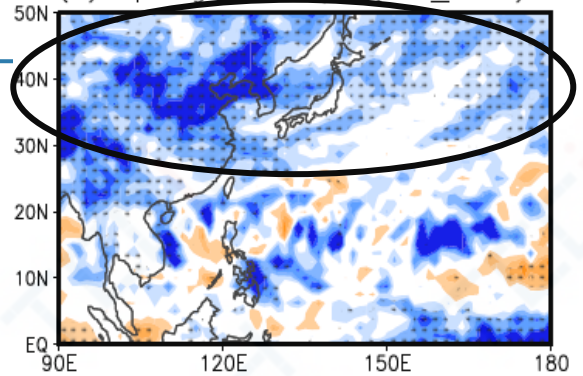


春

秋

(a) Spring: RX5day (MRI_1.25)

(d) Fall

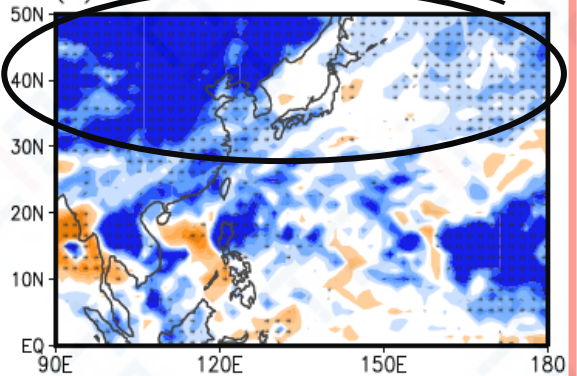
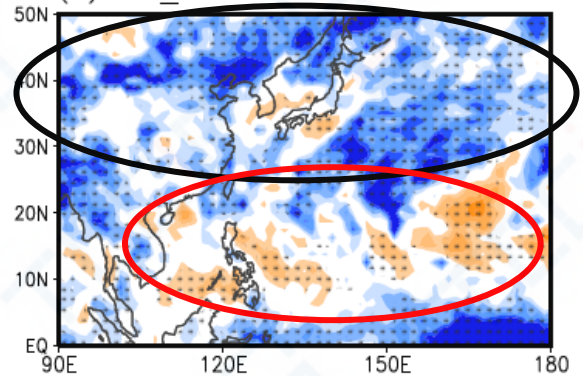


(b) 1st_Wet

梅雨

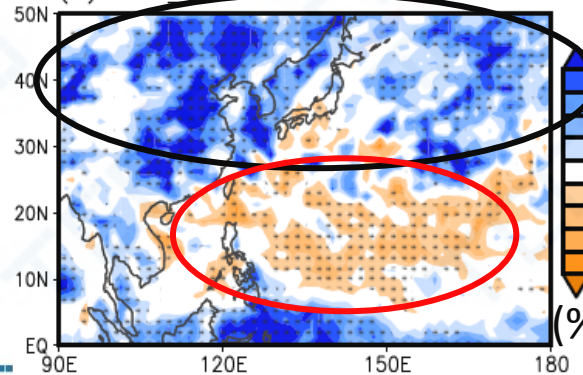
(e) Winter

冬



(c) 2nd Wet

颱風



Changes in **RX5day**
between
RCP8.5_ens and
AMIP

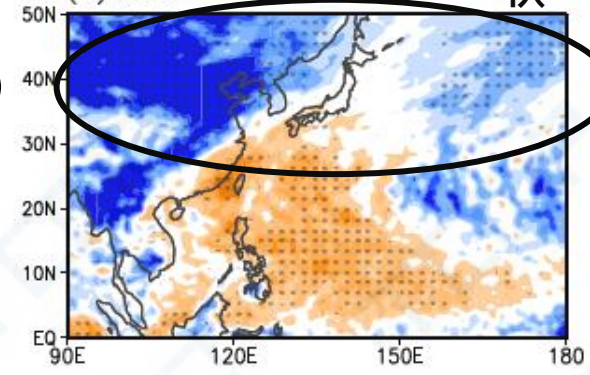
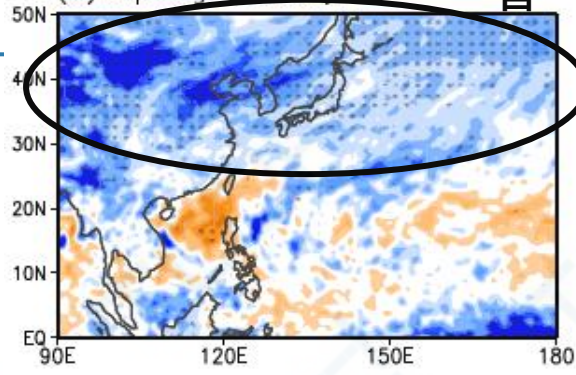
MRI_1.25

春

秋

(a) Spring: RX5day

(d) Fall

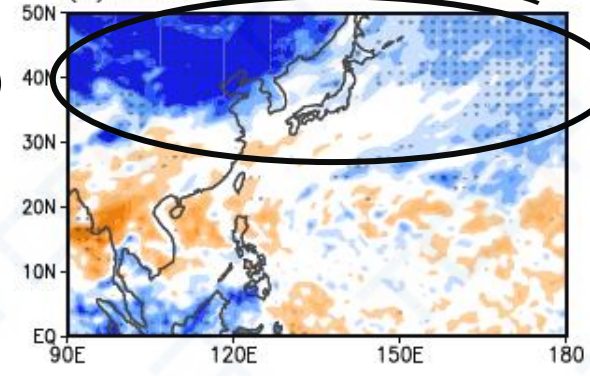
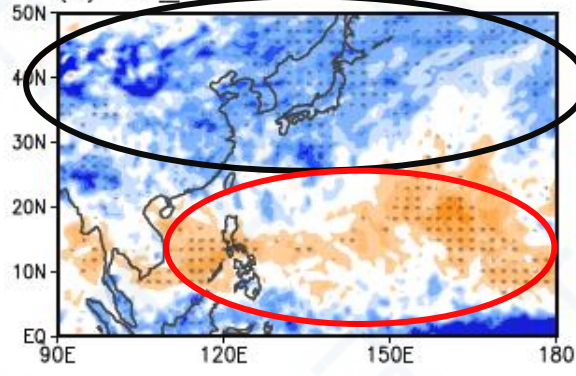


(b) 1st Wet

梅雨

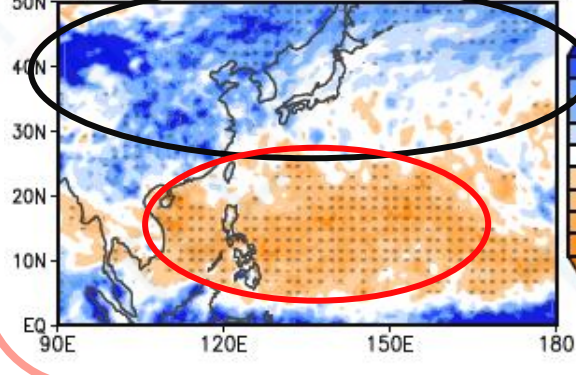
(e) Winter

冬

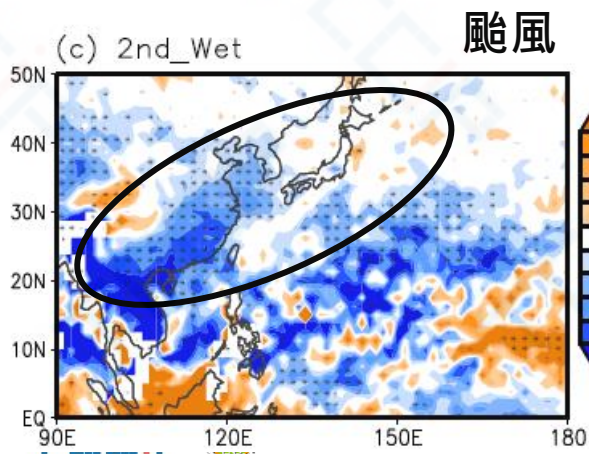
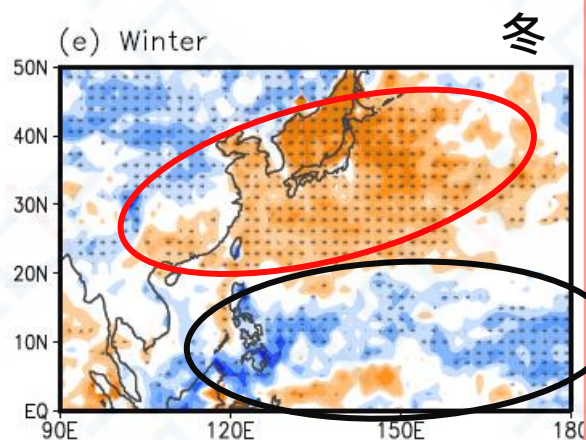
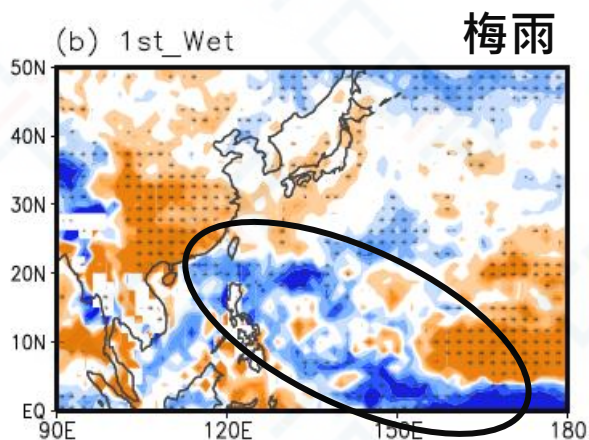
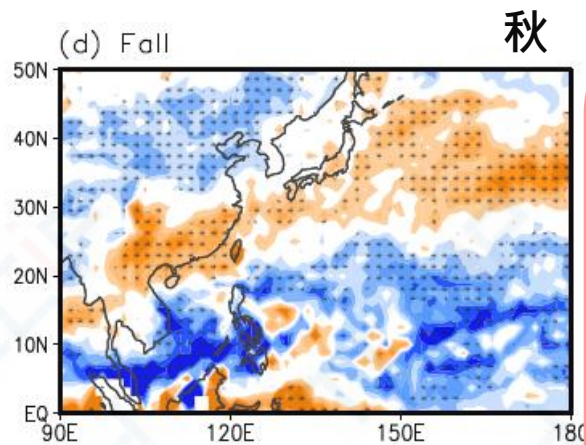
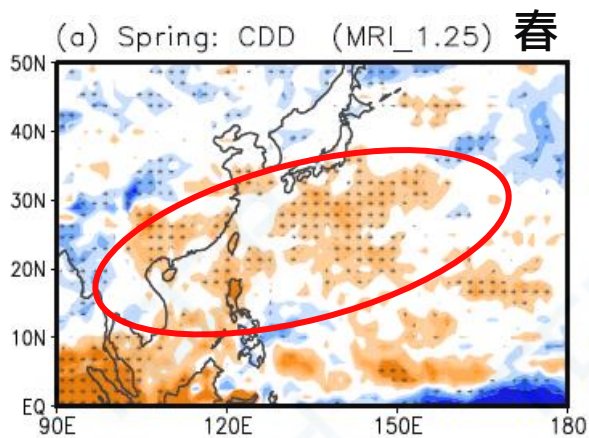


(c) 2nd Wet

颱風

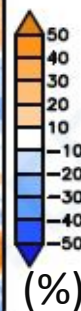
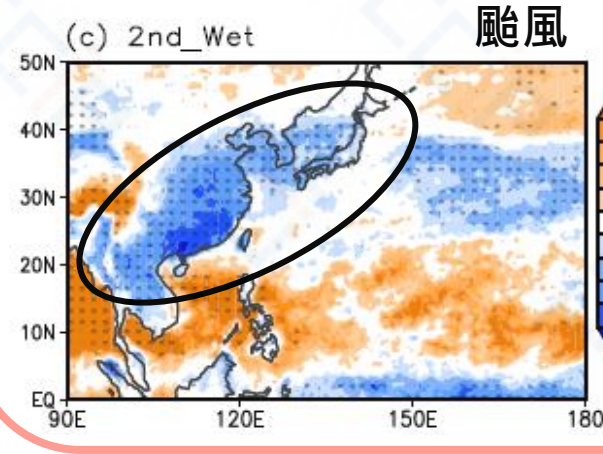
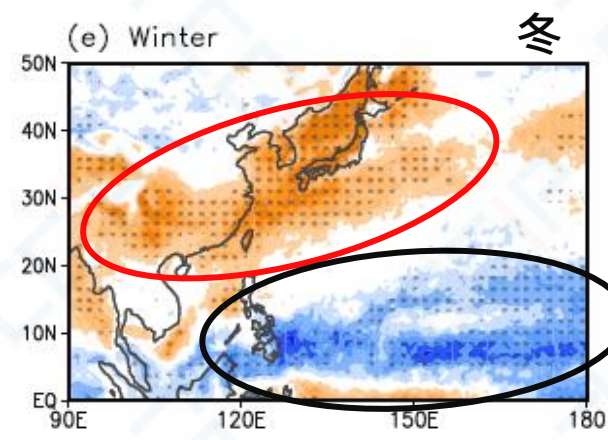
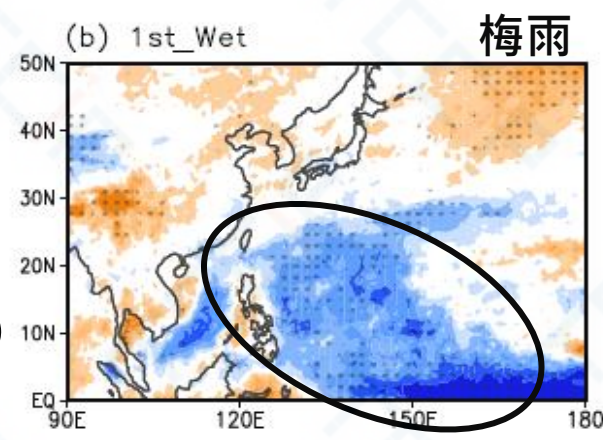
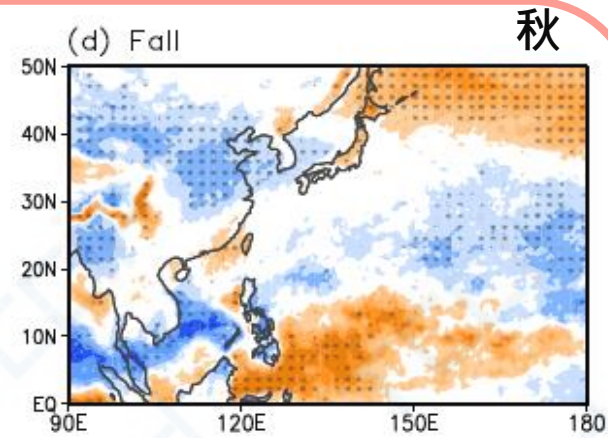
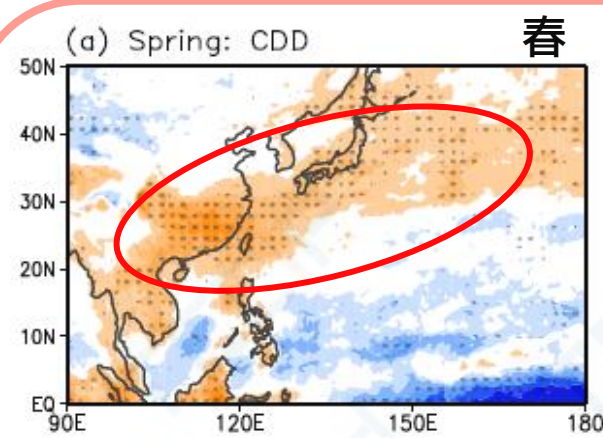
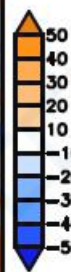


最大五日降雨變遷
HIRAM_c192



Changes in **CDD**
between
RCP8.5_ens and
AMIP

MRI_1.25



連續乾日變遷
HIRAM_c192