



氣象局第二代二步法氣候預報系統預報 之檢驗流程與預報能力評估

李清騰、盧孟明、胡志文
中央氣象局 科技中心

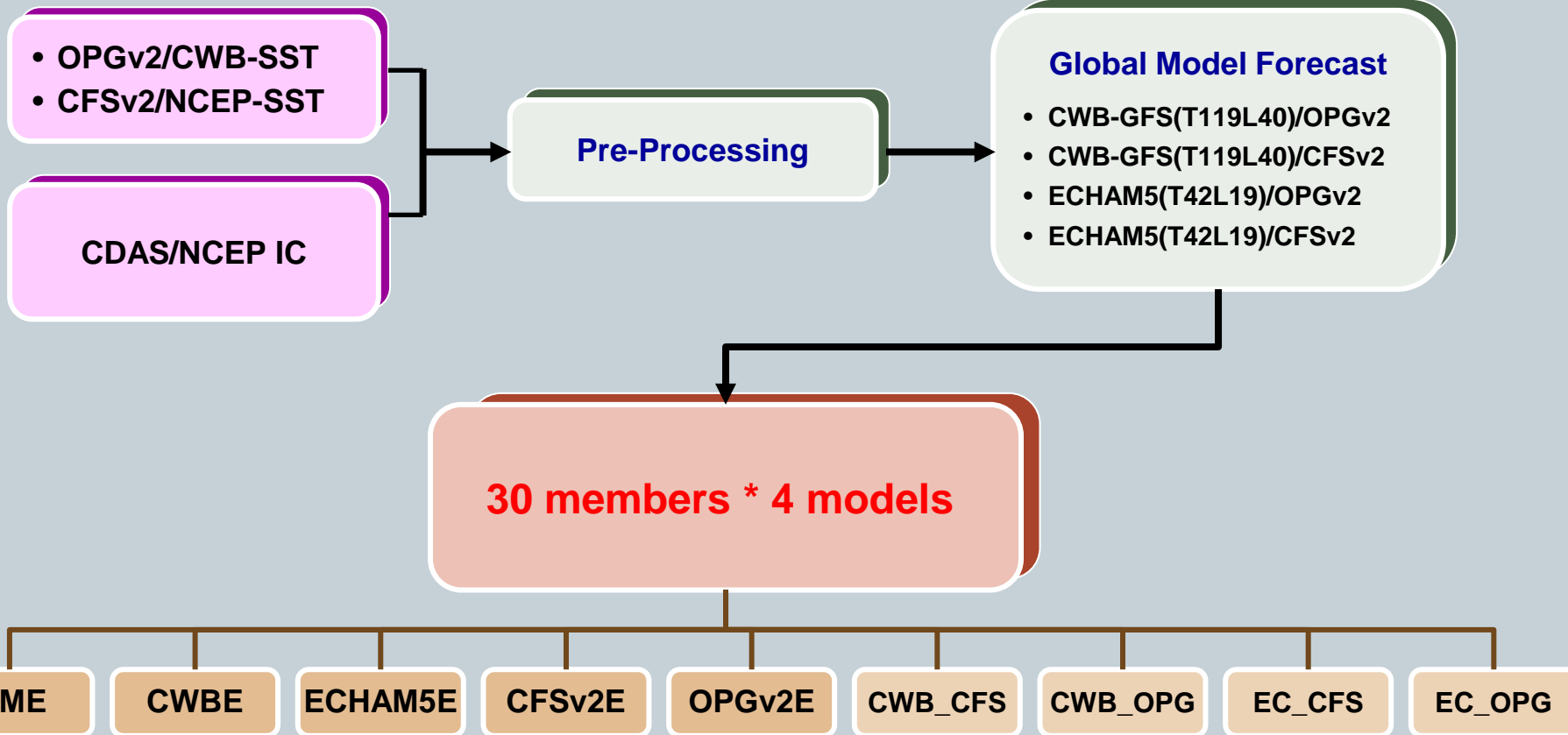
104年天氣分析與預報研討會
9/15-9/17

Outline



- 氣象局模式簡介
- 氣象局檢驗方法介紹
- 氣象局模式歷史預報結果(hindcast)之預報技術得分
- 結論

TCWB-GAMT119L40 Model



CWB Climate Model Hindcast information

	Model Experiment
Experiment design	30-year integration (1982-2011) 9-month integration for each case
Ensemble member	30 members (days) for ensemble mean
Integration time	280 days
Atmospheric Model	CWB-GCM (T119L40) ECHAM5 (T42L19)
SST	OPGSST-v2.0 and NCEP-CFSv2-SST(CFSRR) (OPGSST: 4 statistical models, 2 couple models) (CFSRR: 4 x daily run)
MME	30 members x 4 model = 120 members (<i>MME, CWB-Ens, ECHAM5-Ens</i> <i>CFSsst-Ens, OPGsst-Ens</i>)
Initial Month	May (Jun, Jul, Aug) Nov (Dec, Jan, Feb)

Reanalysis Data



Variables	Source and Format
SST	<i>ERSSTv3b</i> (180 x 89, 2 degree)
T2m, SLP, UV850	<i>NCEP-CFSR</i> (720 x 361, 0.5 degree)
Precipitation	<i>GPCP</i> and <i>CMAP</i> (144 x 72 , 2.5 degree)

Verification Metrics-WMO

Standardized Verification System (SVS) for Long-Range Forecasts (LRF)

長期預報標準校驗系統

Mean climatology 平均氣候場	Rain, Temperature 雨量、溫度	Mean 平均值
Mean variance 平均變異量	Rain, Temperature 雨量、溫度	Mean, Variance 平均值、變異度
Mean bias 平均偏差	Rain, Temperature 雨量、溫度	Mean, Difference 平均值、差異量
Pattern correlation coefficient (PCC) 空間形態相關係數	Rain, Temperature 雨量、溫度	PCC of Mean climatology 平均氣候場空間形態相關係數
Anomaly correlation coefficient (ACC) 距平相關係數圖	Rain, Temperature 雨量、溫度	Temporal correlation of anomaly maps 距平的時間相關係數圖
Root mean square errors (RMSE) 均方根誤差	Rain, Temperature 雨量、溫度	RMSE of Mean bias 平均偏差值的均方根誤差
Heidke skill score (HSS) HSS技術得分	Rain, Temperature 雨量、溫度	HSS (Tercile categories) 評量三分類機率預報技術HSS得分
Gerrity skill score (GSS) GSS技術得分	Rain, Temperature 雨量、溫度	GSS (Tercile categories) 評量三分類機率預報技術GSS得分
Ranked probability skill score (RPSS) RPSS技術得分	Rain, Temperature 雨量、溫度	RPSS (Full probability, PDF) 評量機率預報技術RPSS得分
Relative/Receiver Operating Characteristic score (ROC Score) ROC技術得分	Rain, Temperature 雨量、溫度	ROC Score (Full probability / 10 Bins) 評量機率預報技術ROC得分

Verification Metrics-SST

Sea Surface Temperature (SST) Evaluation 海表面溫度

Major climate modes 主要氣候模態	SST 海表面溫度	EOF 經驗正交函數分析法
ENSO spatial and temporal characteristics 聖嬰現象時空變化特徵	SST 海表面溫度	Mean bias, Correlation, RMSE (of Nino indexes) 以Nino指標為對象計算平均偏差，相關係數，均方根誤差
Indian Ocean SST spatial and temporal characteristics 印度洋海表面溫度時空變化特徵	SST 海表面溫度	Mean bias, Correlation, RMSE (of IOD indexes) 以印度洋海溫偶極(Indian Ocean Dipole)指標為對象計算平均偏差，相關係數，均方根誤差
South China Sea SST spatial and temporal characteristics 南海海表面溫度時空變化特徵	SST 海表面溫度	Mean bias, Correlation, RMSE (of SCS, N-SCS, E-SCS, S-SCS) 南海整體與北、中、南部

Verification Metrics-

Tropical & East Asia and WNP

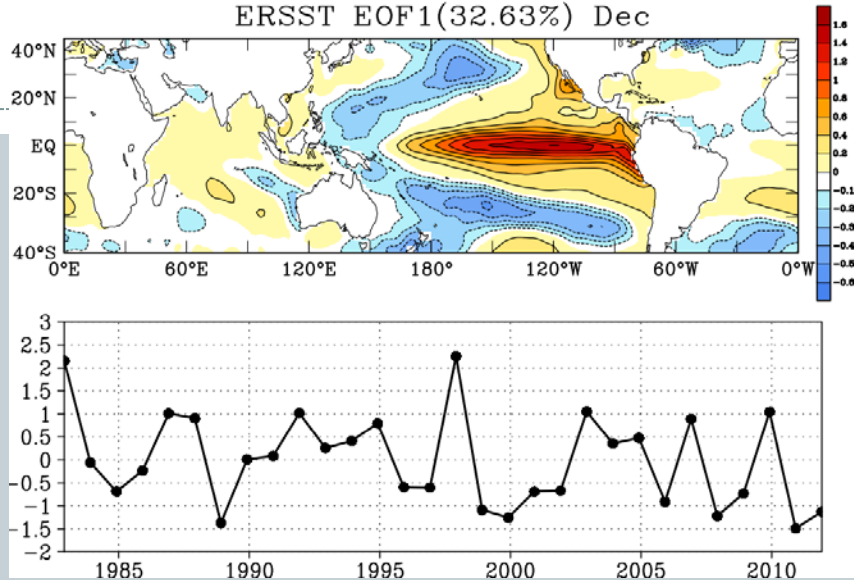
Tropics 熱帶		
Global 全球預報	Rain, Temperature 雨量、溫度	Seasonal contrast (30S-30N) 季節對比
Tropical Belt (30S-30N): AF(0-50E), IO(50E-110E), WP(110E-180E), EP(180W-80W), AO(80W-0) 熱帶及分區預報	Rain, Temperature 雨量、溫度	RMSE, ACC 均方根誤差、距平相關係數圖
Taiwan and the surrounding monsoon region (TAIWAN) (0-40N, 100E-150E) 台灣附近季風區預報	Rain, Temperature 雨量、溫度	RMSE, ACC (NW2TW, SW2TW, TW, SE2TW, NE2TW) 均方根誤差、距平相關係數圖 (台灣附近5個區域)

East Asia and western North Pacific Monsoons 東亞與西北太平洋

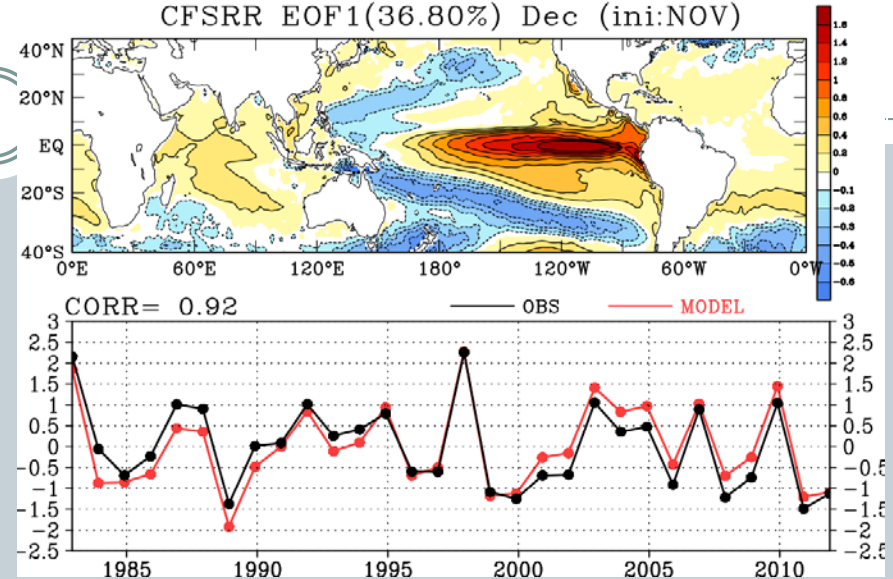
Winter Monsoon 冬季季風	Sea Level Pressure (SLP), U-300hPa, U-200hPa 海平面氣壓、300hPa緯向風、 200hPa緯向風	Bias, RMSE, Correlation (Indexes: SMH, EWW, EJL, ELY) 偏差、均方根誤差、距平相關係 數圖 (季風指數)
Summer Monsoon 夏季季風	(U,V) at 850hPa and 200hPa 850hPa風場、200hPa風場	Bias, RMSE, Correlation (Indexes: WNPMI, WYI, ASMI, SAMI, DU2) 偏差、均方根誤差、距平相關係 數圖 (季風指數)
West Pacific Subtropical High (WPSH) 西北太平洋副熱帶高壓	GPH at 850hPa 850hPa重力位高度	RMSE, Correlation 均方根誤差、距平相關係數圖

ENSO spatial and temporal characteristics

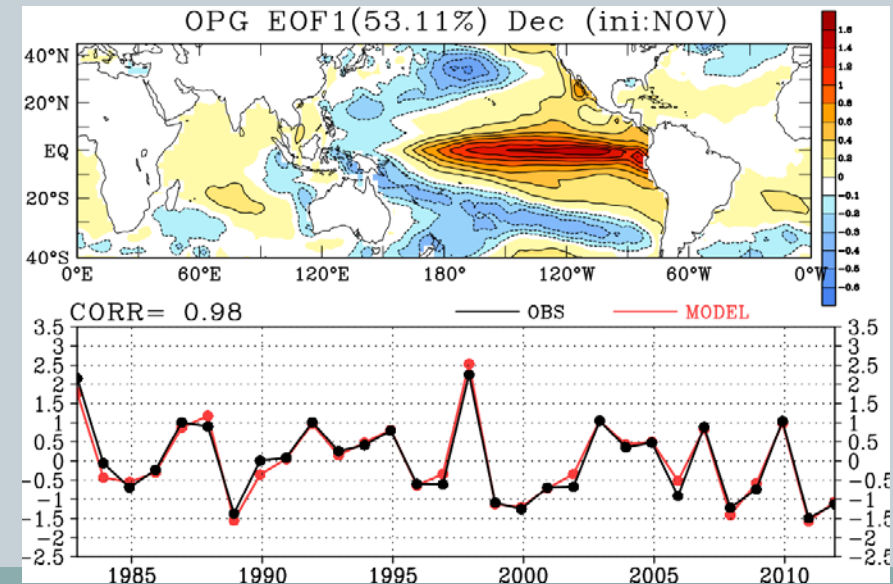
ERSST EOF1(32.63%) Dec



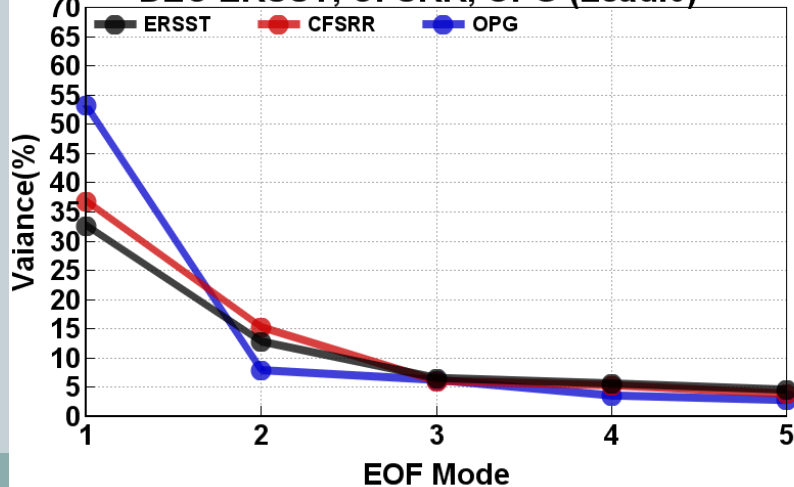
CFSRR EOF1(36.80%) Dec (ini:NOV)



OPG EOF1(53.11%) Dec (ini:NOV)

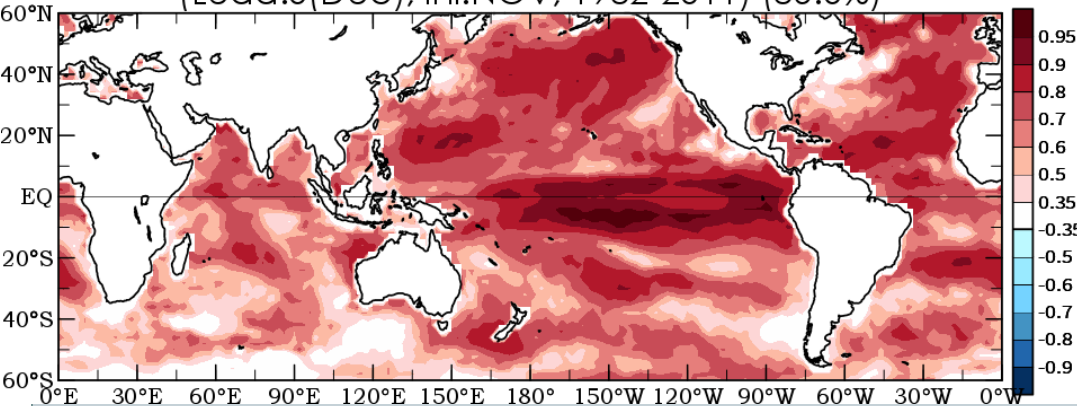


DEC ERSST, CFSRR, OPG (Lead:0)

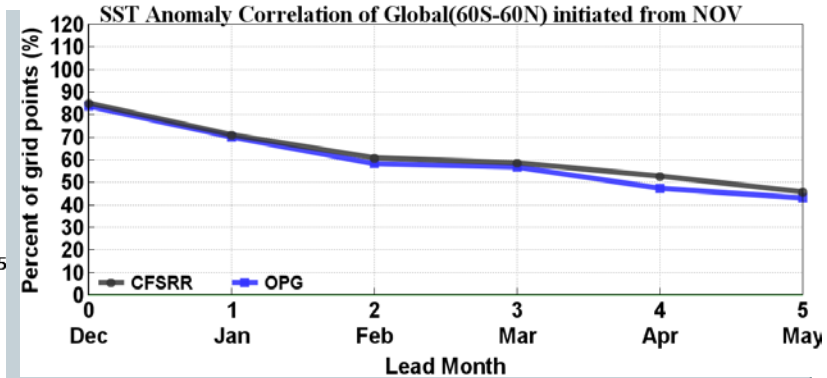
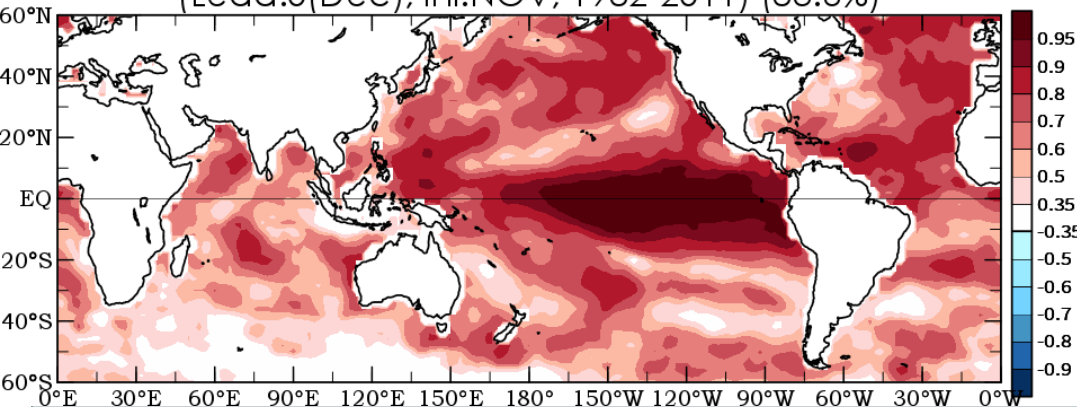


SST Anomaly Correlation

SST CORR between ERSST & CFSv2 SST
(Lead:0(Dec), ini:NOV, 1982-2011) (85.0%)



SST CORR between ERSST & OPGv2 sst
(Lead:0(Dec), ini:NOV, 1982-2011) (83.6%)

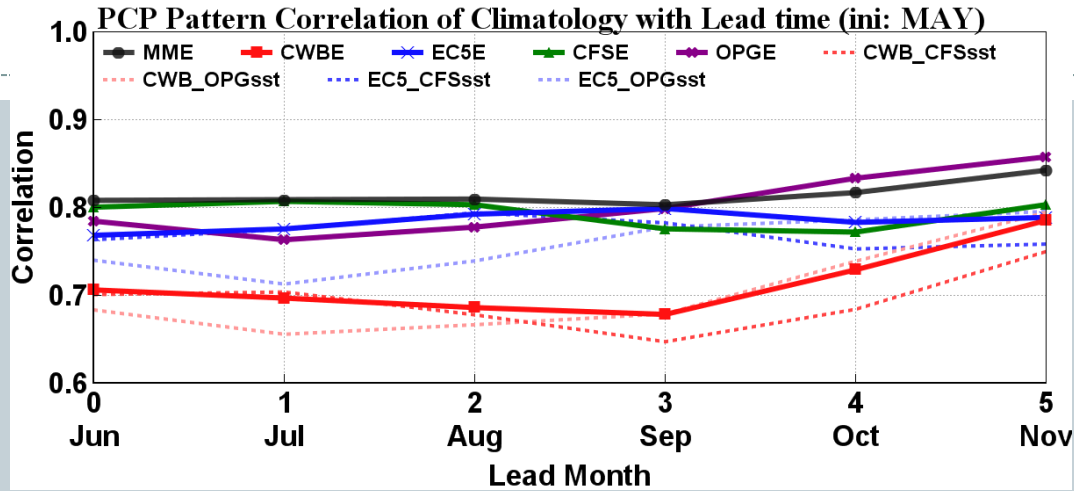


1. CFSv2與OPG對於SST的EOF表現均有相當程度的掌握。
2. SST的距平相關係數得到，兩者的SST在赤道太平洋地區有高的預報技術。
3. CFSv2整體表現較好，但赤道中、東太平洋技術得分則比OPGv2偏弱。

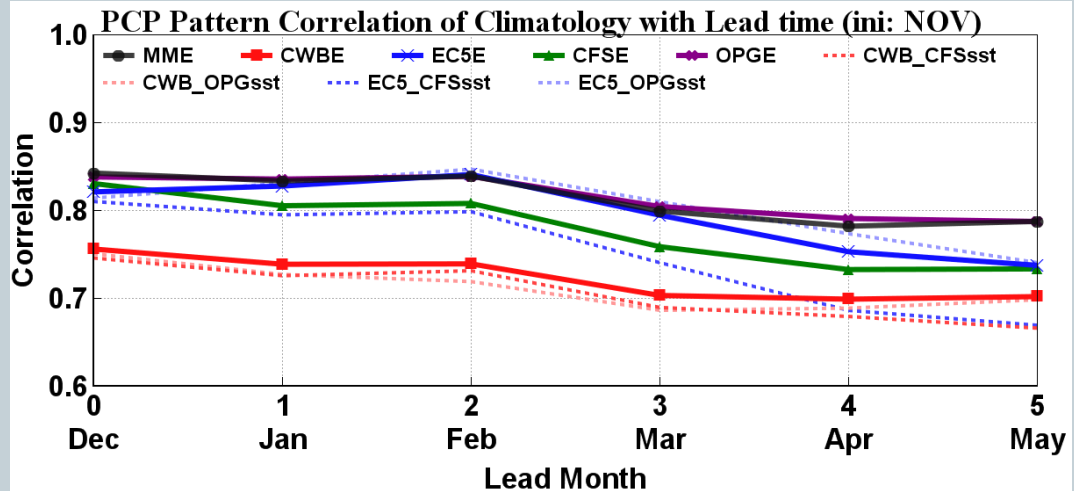
Mean climatology Skill (Precipitation)

Pattern Correlation over Global Domain of Precipitation Climatology between GPCP and others climate model with Lead month

Initial: MAY



Initial: NOV



1. MME 有最高的形態相關係數值，尤其是領先前四個月的預報結果。
2. EC的相關係數值明顯比CWB好，但仍是MME最高。

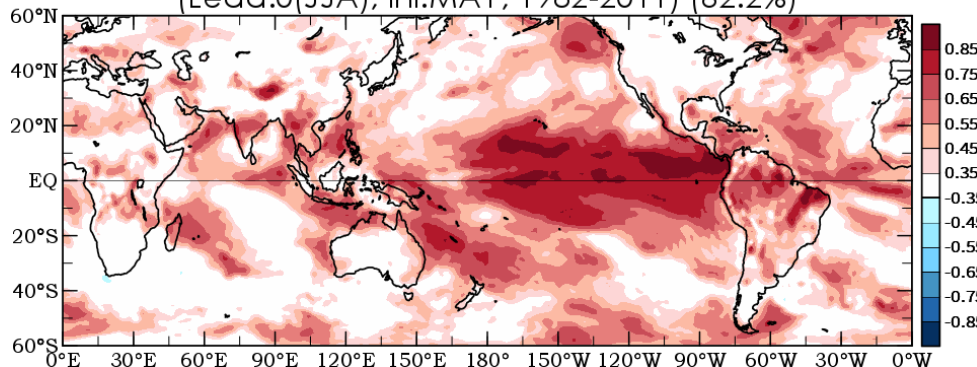
Season Forecast Skill (Anomaly Correlation; MME)

T2m

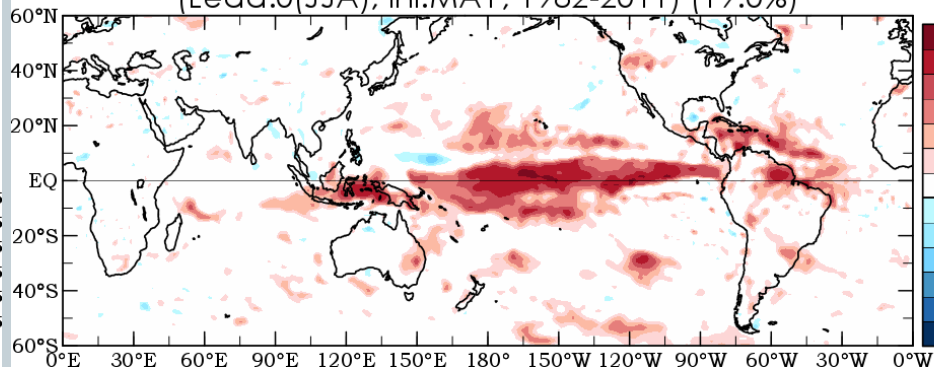
Precipitation

Initial: MAY (JJA)

T2m Corr between TCWB2Tv2-MME & CFSR
(Lead:0(JJA), ini:MAY, 1982-2011) (62.2%)

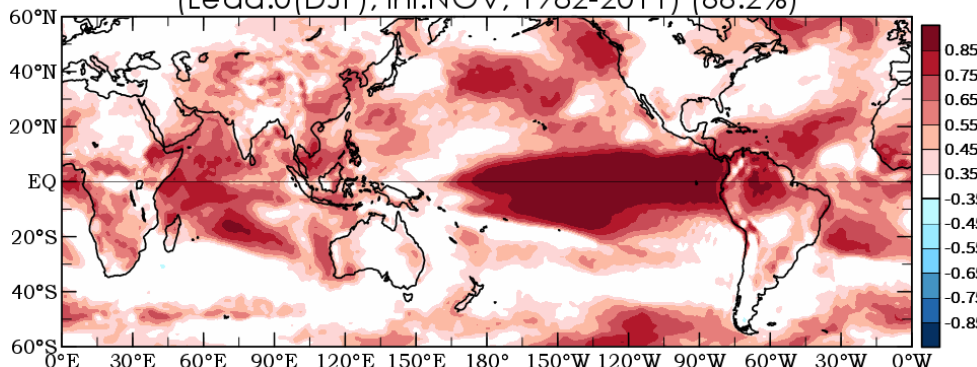


Precipitation Corr between TCWB2Tv2-MME & GPCP
(Lead:0(JJA), ini:MAY, 1982-2011) (19.0%)

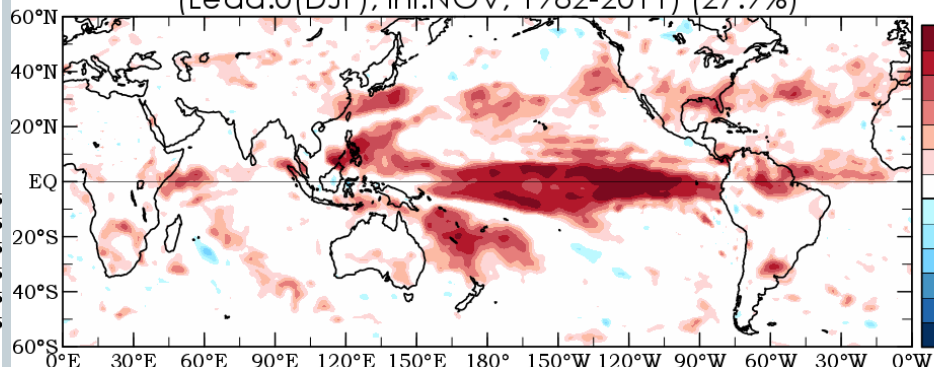


Initial: NOV (DJF)

T2m Corr between TCWB2Tv2-MME & CFSR
(Lead:0(DJF), ini:NOV, 1982-2011) (66.2%)



Precipitation Corr between TCWB2Tv2-MME & GPCP
(Lead:0(DJF), ini:NOV, 1982-2011) (27.9%)



1. 冬季的預報結果比夏季好、溫度的預報結果比雨量好。
2. 高的預報技術得分集中於赤道中、東太平洋地區，高緯度地區預報能力偏弱。
3. 海面上的溫度、雨量預報結果明顯優於陸地。

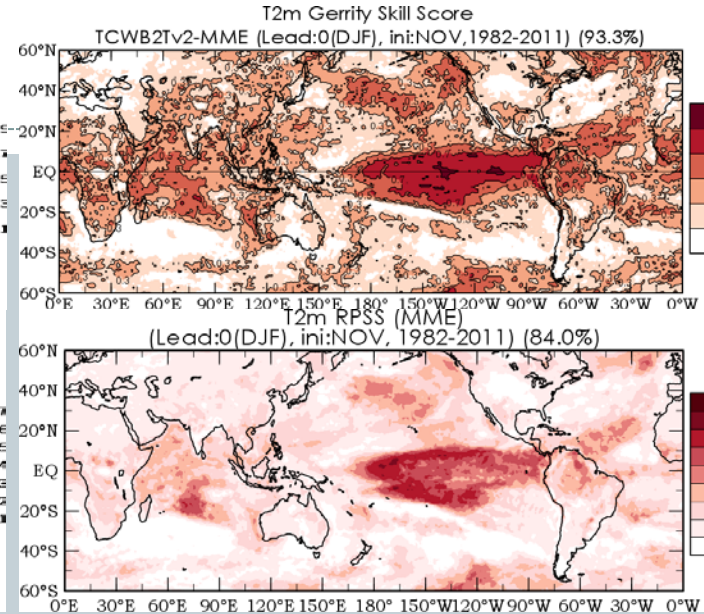
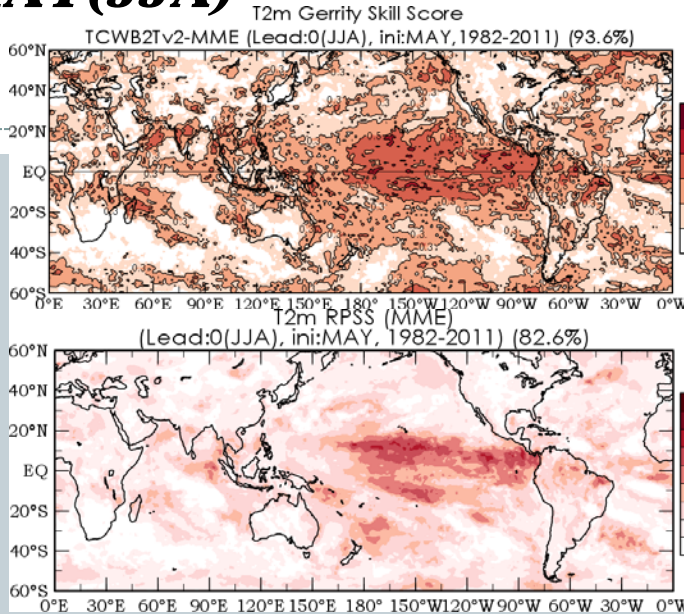
SKILL Score of Lead-0 month

Ini:MAY(JJA)

Ini:NOV(DJF)

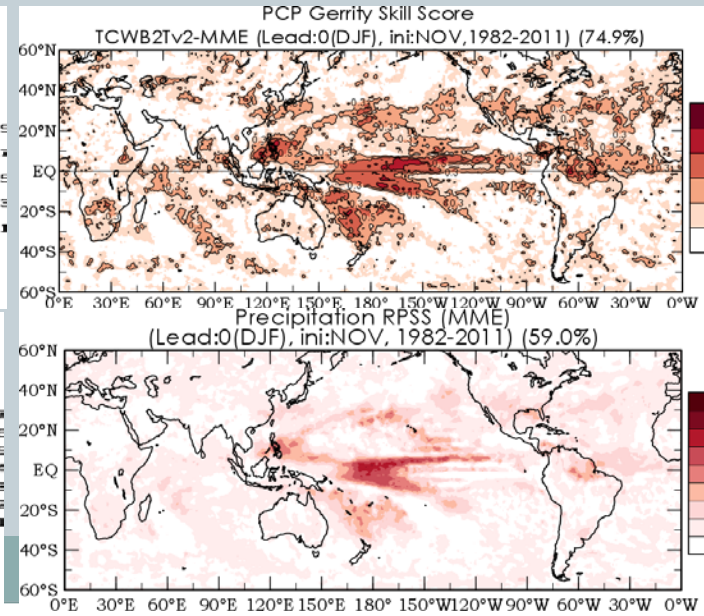
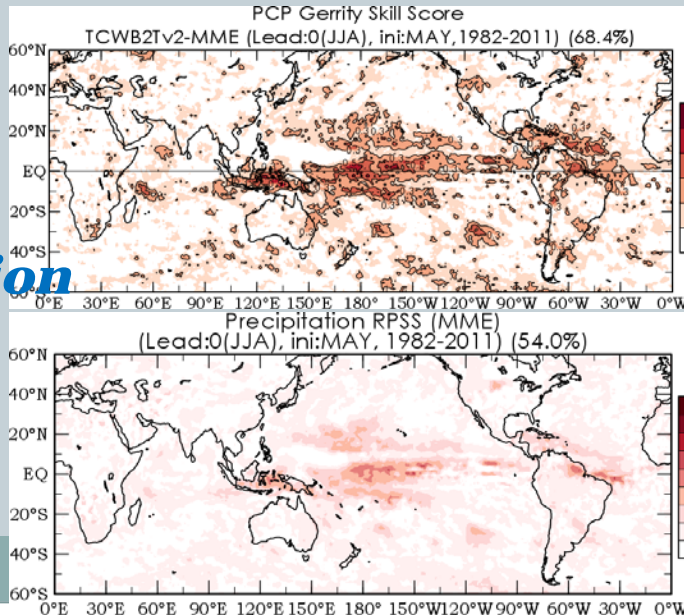
T2m

Precipitation



GSS

RPSS



GSS

RPSS

Monsoon Index

Summer Monsoon Index

$$\mathbf{WPSH} = H_{850}(15^{\circ}\text{N}-25^{\circ}\text{N}, 115^{\circ}\text{E}-150^{\circ}\text{E})$$

$$\mathbf{WNPM} = u_{850}(5^{\circ}\text{N}-15^{\circ}\text{N}, 110^{\circ}\text{E}-130^{\circ}\text{E}) - u_{850}(20^{\circ}\text{N}-30^{\circ}\text{N}, 110^{\circ}\text{E}-140^{\circ}\text{E})$$

$$\mathbf{WYI} = U_{850} - U_{200} \text{ averaged over } 0-20^{\circ}\text{N}, 40^{\circ}\text{E}-110^{\circ}\text{E}$$

Winter Monsoon Index

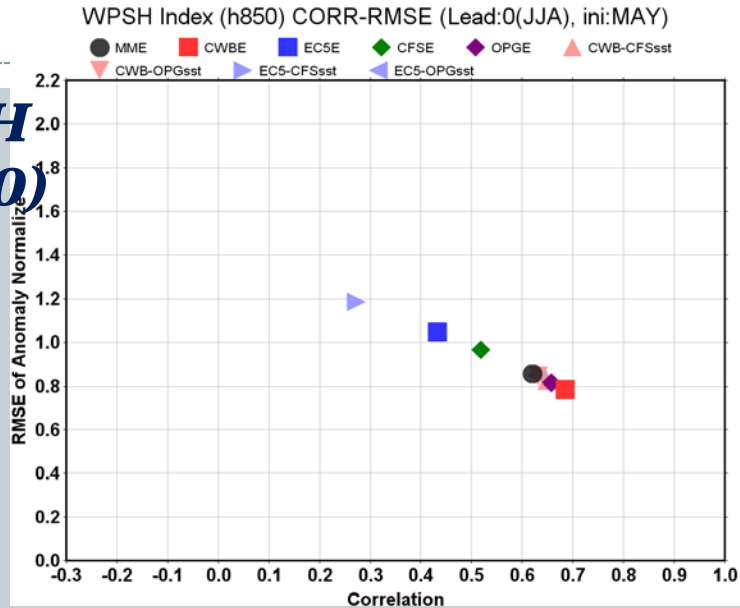
$$SMH = SLP(40^{\circ} - 60^{\circ} N, 70^{\circ} - 120^{\circ} E)$$

$$EJL = U_{300}(27.5^{\circ} - 37.5^{\circ} N, 110^{\circ} - 170^{\circ} E) - U_{300}(50^{\circ} - 60^{\circ} N, 80^{\circ} - 140^{\circ} E)$$

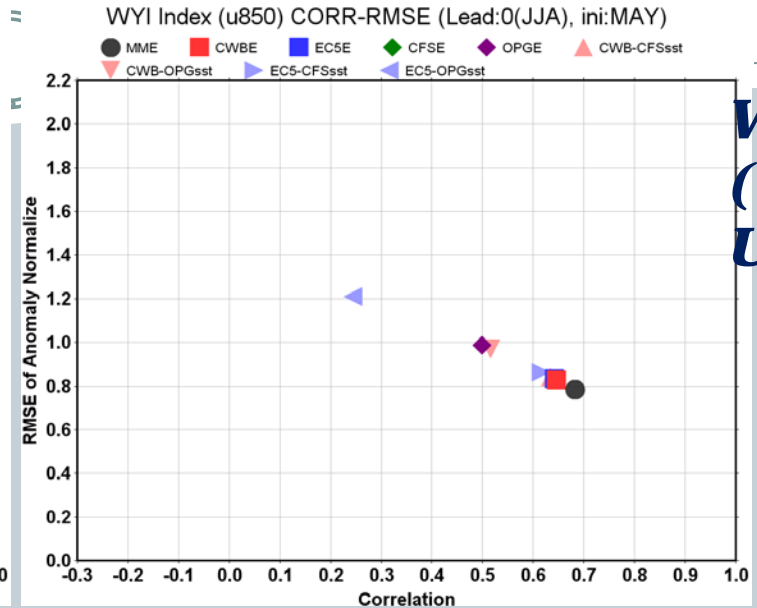
$$ELY = \left\{ \begin{array}{l} \left[U_{200}(30^{\circ} - 35^{\circ} N, 90^{\circ} - 160^{\circ} E) - \right. \\ \left. U_{200}(50^{\circ} - 60^{\circ} N, 70^{\circ} - 170^{\circ} E) \right] + \\ \left[U_{200}(30^{\circ} - 35^{\circ} N, 90^{\circ} - 160^{\circ} E) - \right. \\ \left. U_{200}(5^{\circ} S - 10^{\circ} N, 90^{\circ} - 160^{\circ} E) \right] \end{array} \right\} \times 0.5$$

Summer Monsoon Index (ini: MAY, JJA)

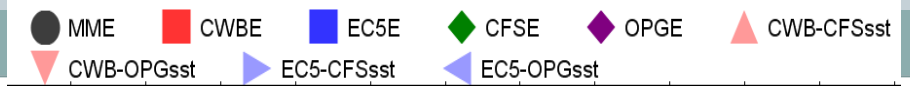
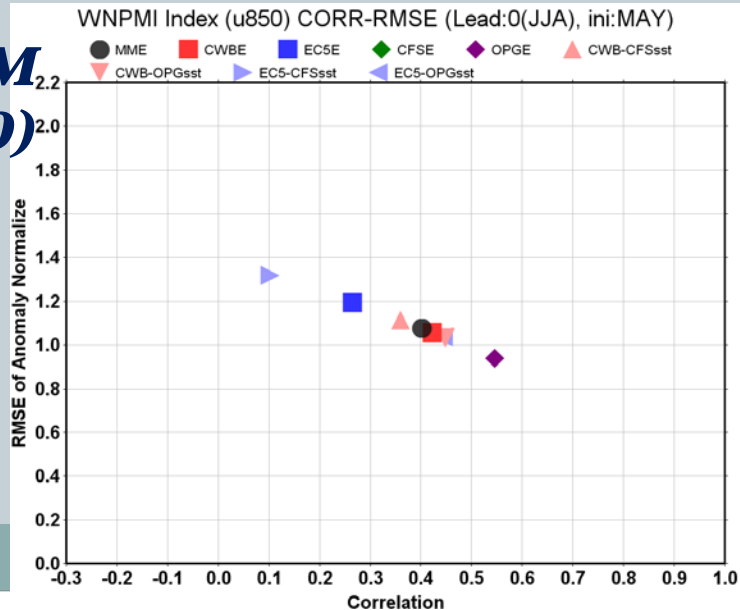
**WPSH
(H850)**



**WYI
(U850,
U200)**

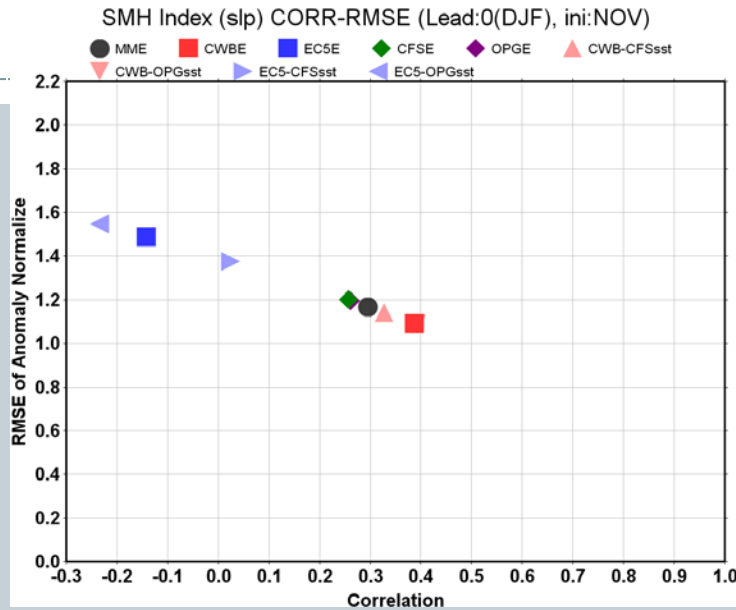


**WNPMI
(U850)**

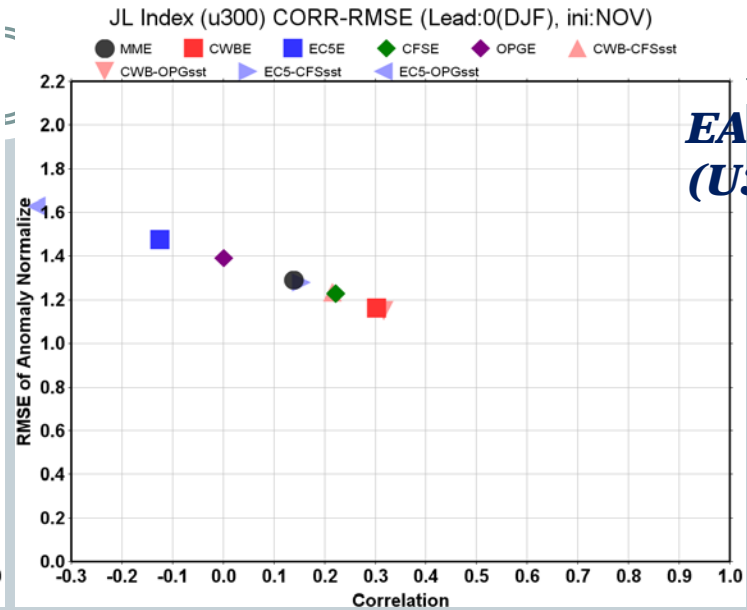


Winter Monsoon Index (ini: NOV, DJF)

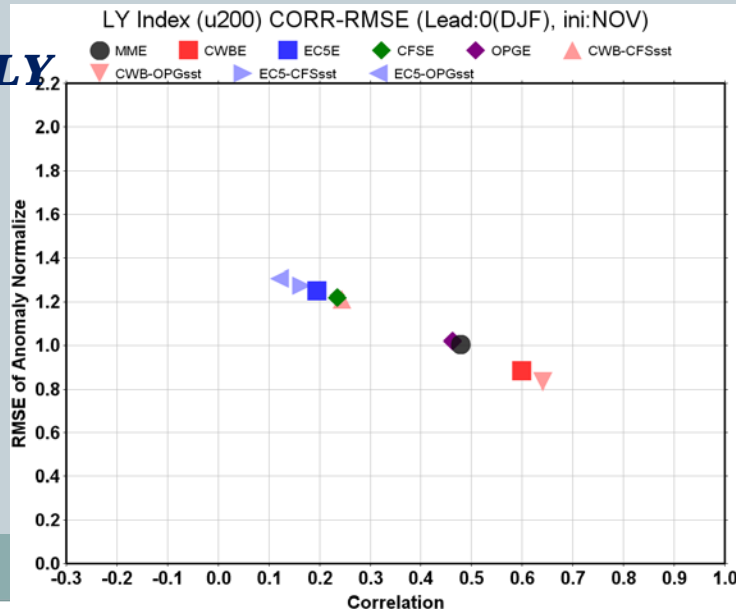
**SMH
(SLP)**



**EAWM-JL
(U300)**



**EAWM-LY
(U200)**



Monsoon regions of Precipitation

印度夏季季風區 (ISM)
65°E-105°E, 5°N-27.5°N

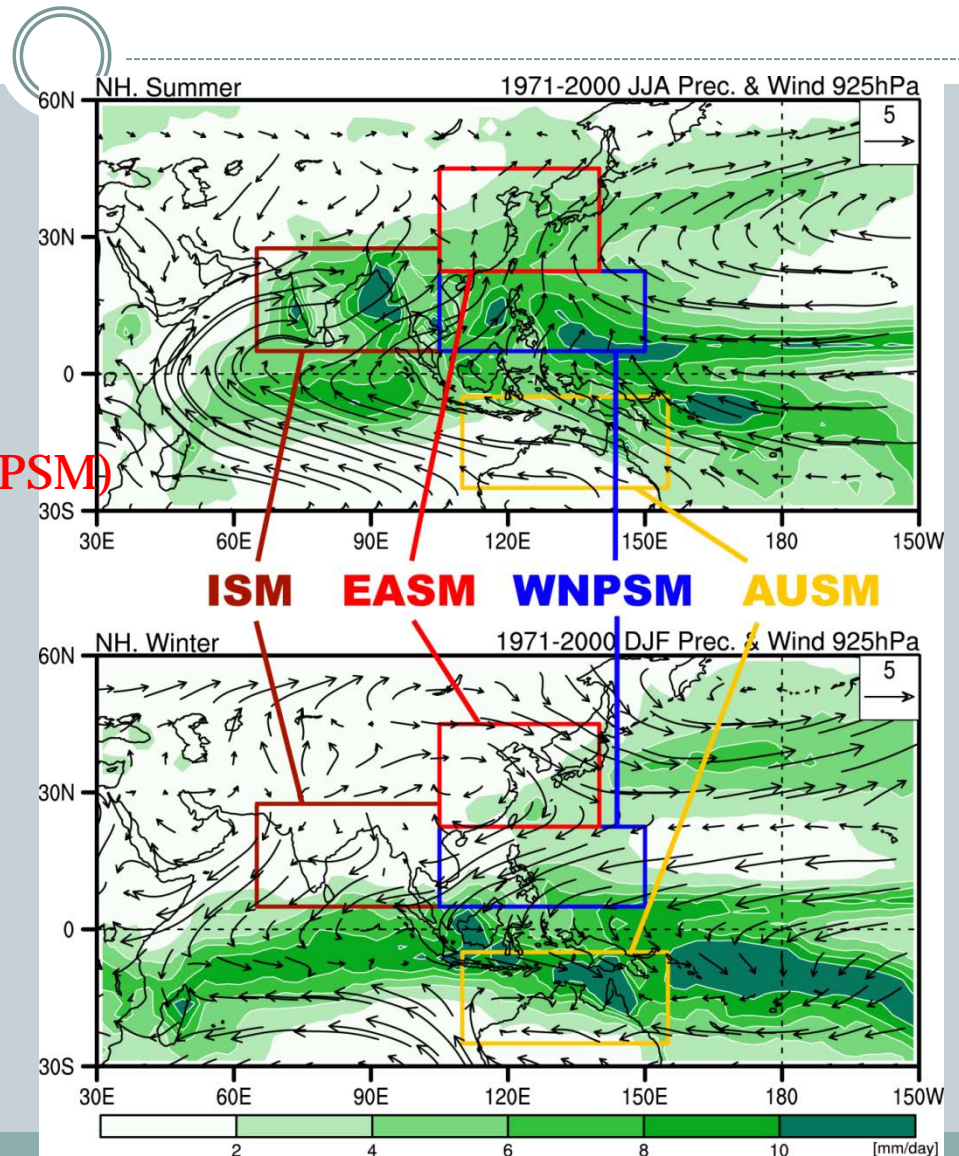
東亞夏季季風區 (EASM)
105°E-140°E, 22.5°N-45°N

西北太平洋夏季季風區 (WNPSM)
105°E-150°E, 5°N-22.5°N

澳洲季風區 (AUSM)
110°E-155°E, 5°S-25°S

Ini: MAY

Ini: NOV

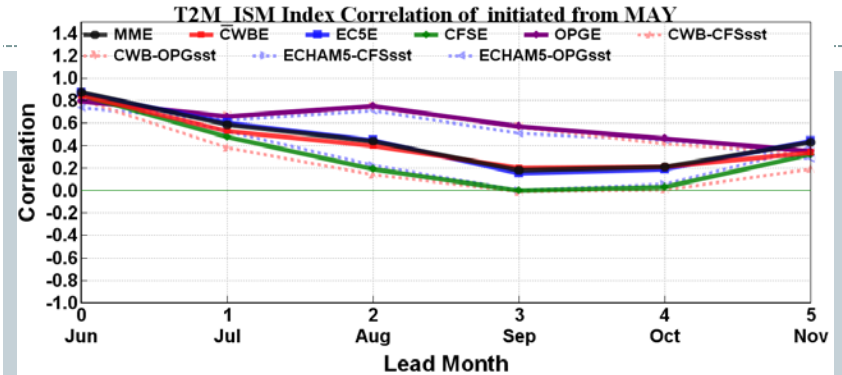
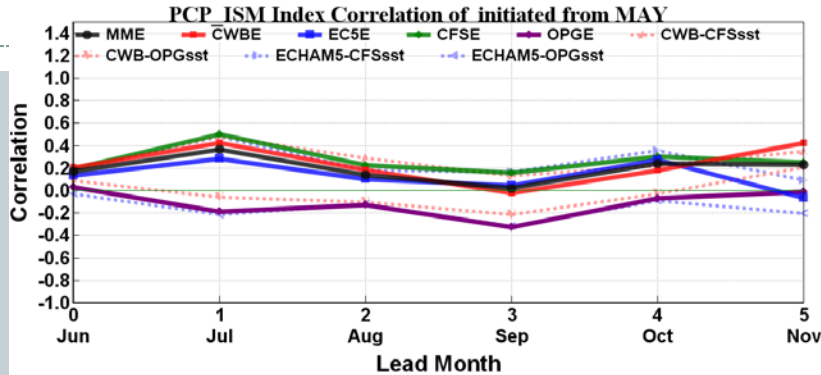


Precipitation & T2m over Monsoon Regions (ini:May)

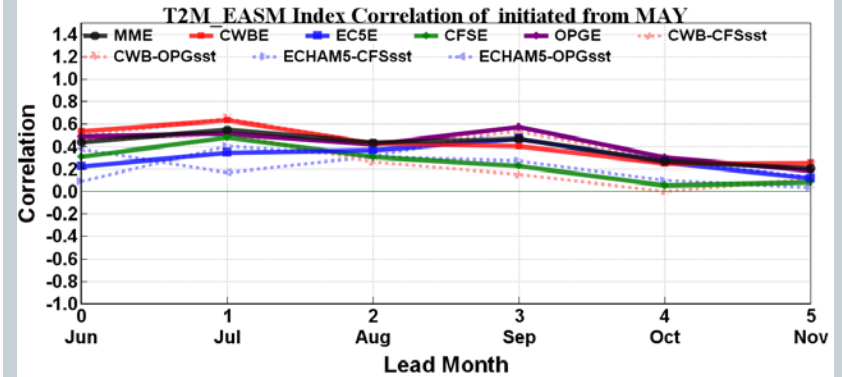
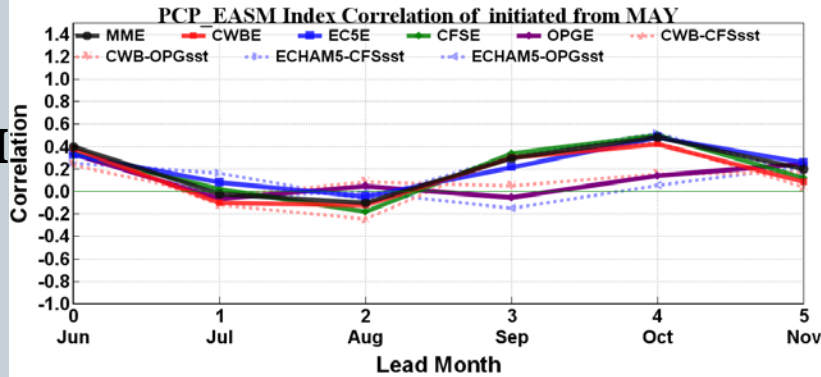
Precipitation

T2m

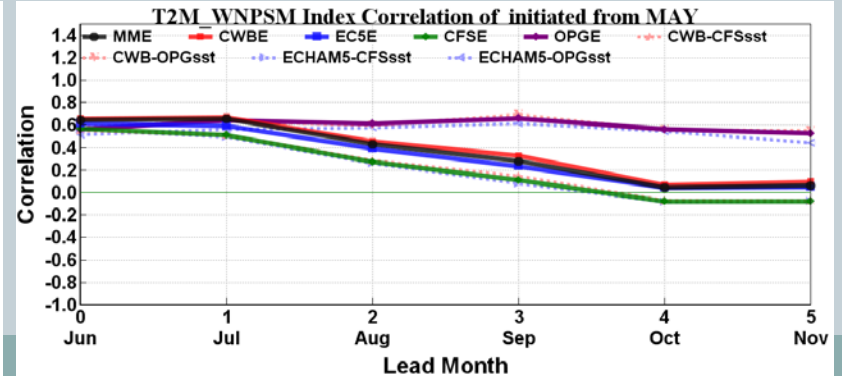
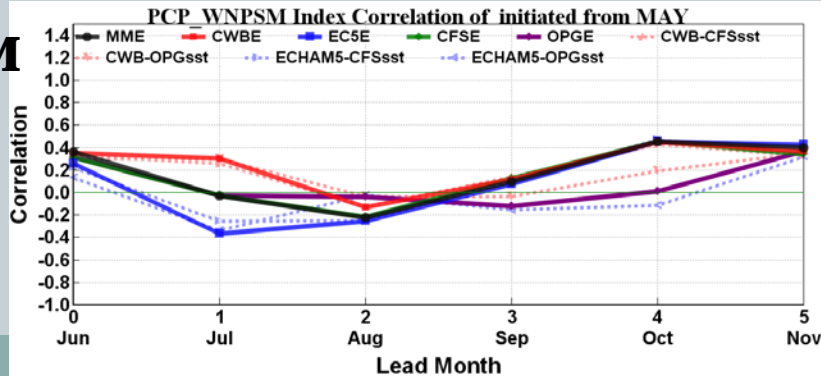
ISM



EASM



WNPSM



Summary



- 氣象局已建立一套完整的檢驗系統，未來新一代高解析度模式之預報結果將根據此檢驗系統來評估模式的預報能力與誤差範圍。
- 多模式系集平均(MME)的結果都比各個系集平均，無論氣候平均場或是距平相關係數都有最高的預報技術得分。
- 溫度場的預報技術得分明顯比雨量高出許多，得分最高區域集中在中、東太平洋地區，且海洋區域的預報結果明顯比陸地上區域好。
- 夏季、冬季季風指標都顯示此氣候模式具有領先兩個月的預報技術，但在雨量預報則只有領先一個月是具有預報技術。



Any Question ?

