MRI-JMA AGCM 與ECHAM5模式推估值之動力降尺度結果比較

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17 Jan. 2013

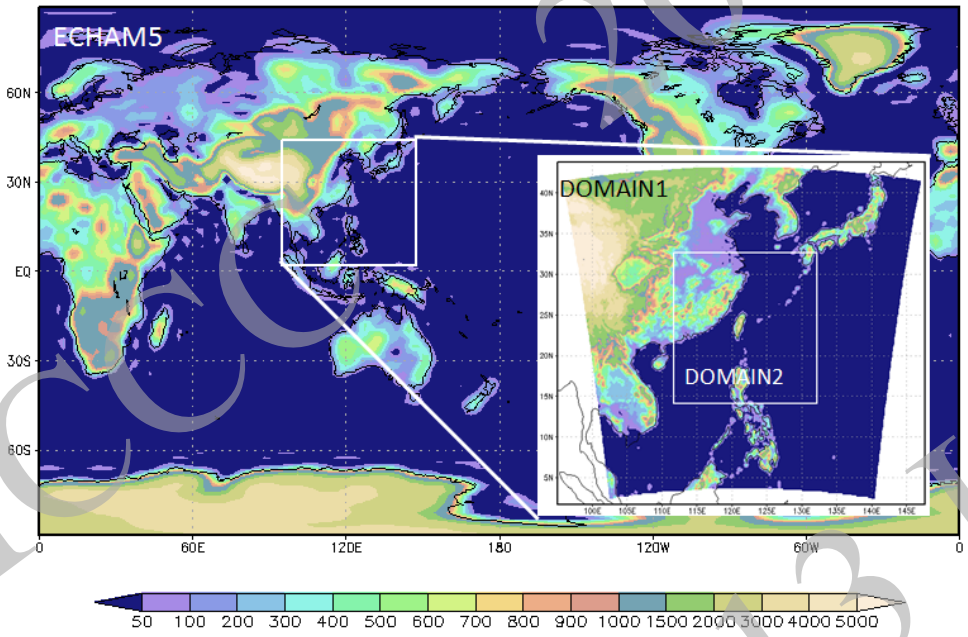
ECHAM5 & MRI 模式、動力降尺度簡介

Introduction: dynamical downscaling

- Existing Global climate models (GCMs)typical run at a scale of 200 km which is too coarse for application regional or local
- Especially for variables that depend on regional topographic, such as precipitation, surface wind and temperature
- Dynamical downscaling with regional climate model is an essential component to fill the gap between GCMs and regional application
- The RCM is not intended to modify/correct the large scale circulation of the AOGCM but is intednted to add regional detail in response to regional scale forcing (topography, coastlines, and land use/land cover) as it interacts with the larger-scale atmospheric circulations (Hanssen et al.; 2003, Lo et al. 2008; …)

ECHAM5-WRF dynamical downscaling

- IPCC AR4中ECHAM5 的模擬結果作為動力降尺度之基本場, 解析度為T63，資料網格為192x96，經向網格間距為1.875˚(約200公里)，緯向為非等間距網格，垂直分為17層，模式最頂層氣壓為10 hPa
- ECHAM5-WRF



WRF: Domain1 : 301x301 Δx,y=15km FDDA
Domain2 : 382x400 Δx,y=5km, vertical 45 levels

ECHAM5-WRF downscaling
Model Description and Experimental setup

- Study Periods:
  1979-2003 (Present), 2015-2039 (Near-future), 2075-2099 (End 21c)

- WRF setup:
  Domain1 (15km): FDDA, Cumulus option: Kain-Fritsch scheme
  Domain2 (5km): no nudging, no cumulus scheme
  Cold start every month and run for one month

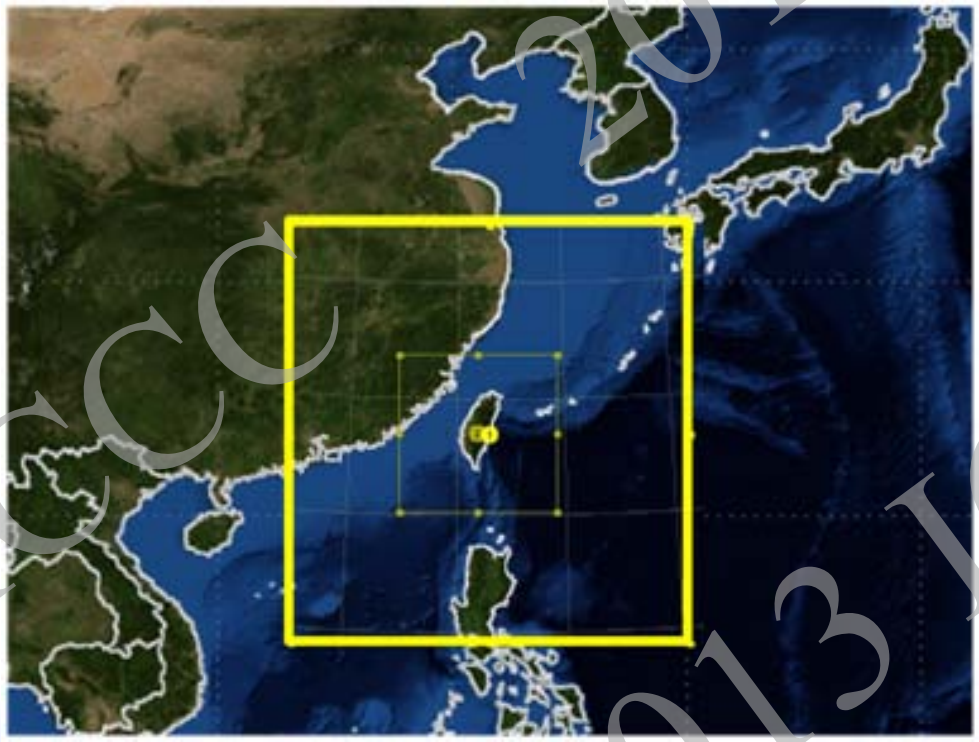
Physical options

Noah Land surface model, Cam LW Scheme
YSU Boundary Scheme, Cam SW scheme
WSM 5-class microphysics, M-O surface layer scheme

- Observation: TCCIP 1 km uniform data
  (From Team 1)

MRI downscaling and set up

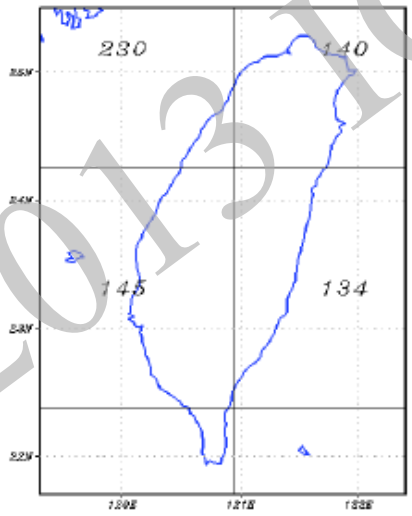
- MRI-JMA 模式係根據日本氣象廳(Japan Meteorological Agency, JMA)在天氣預報作業上使用的數值模式所發展而成具有TL959極高水平解析度，全球網格數為 ，網格間距約20 公里；垂直方向上有60 層，模式最頂層氣壓為0.1 hPa

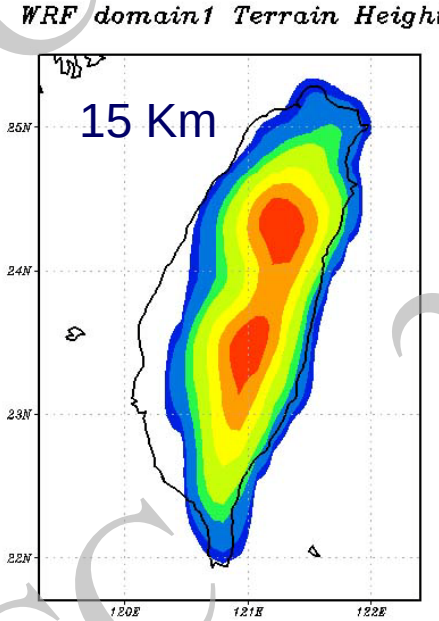


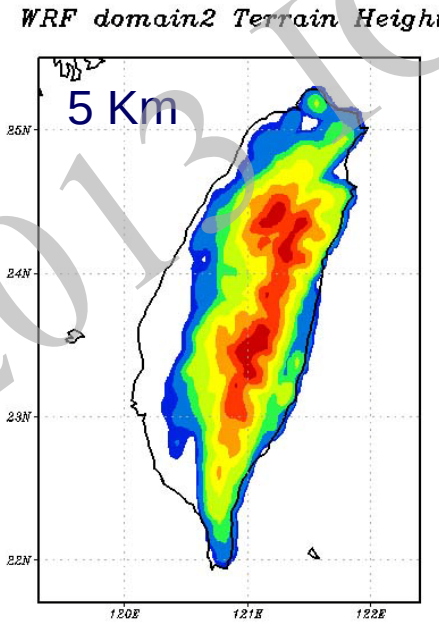
使用一層巢狀網格，水平解析度為5公里，網格點數 380*400 。
垂直解析度為36層

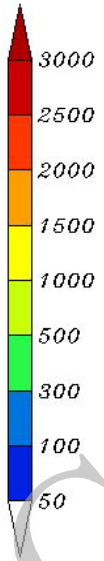
ECHAM5 & WRF Topographic

ECHAM5 terrain

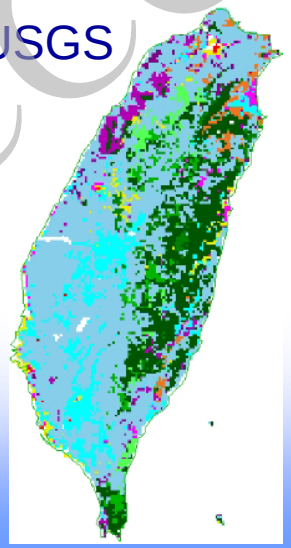






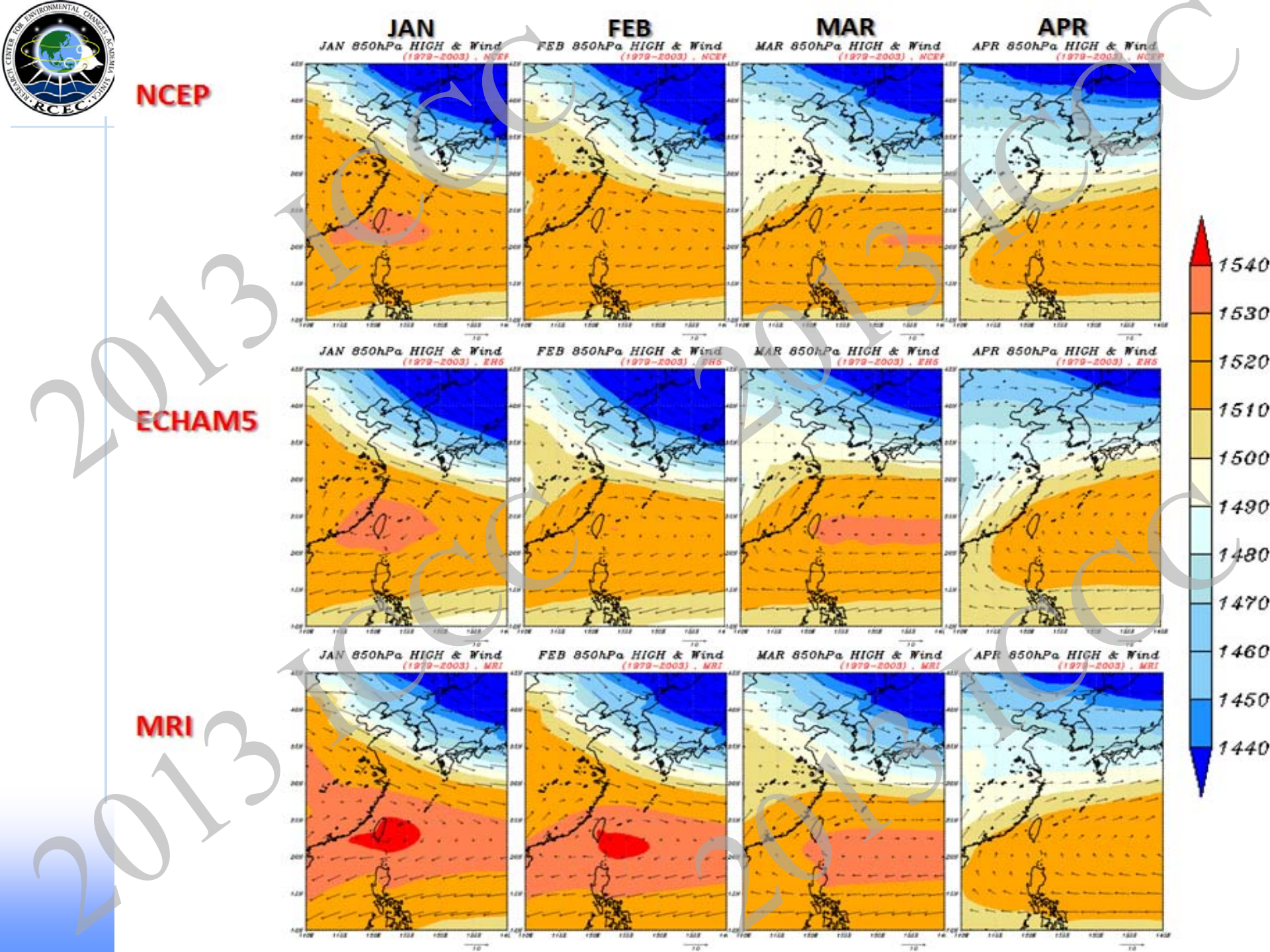


USGS



TCCIP

ECHAM5 & MRI
區域環流、高度場比較


JAN
FEB
MAR
APR
NCEP
ECHAM5
MRI
JAN 850hPa HIGH & Wind (1979-2003) , NCEP
FEB 850hPa HIGH & Wind (1979-2003) , NCEP
MAR 850hPa HIGH & Wind (1979-2003) , NCEP
APR 850hPa HIGH & Wind (1979-2003) , NCEP
JAN 850hPa HIGH & Wind (1979-2003) , EH5
FEB 850hPa HIGH & Wind (1979-2003) , EH5
MAR 850hPa HIGH & Wind (1979-2003) , EH5
APR 850hPa HIGH & Wind (1979-2003) , EH5
JAN 850hPa HIGH & Wind (1979-2003) , MRI
FEB 850hPa HIGH & Wind (1979-2003) , MRI
MAR 850hPa HIGH & Wind (1979-2003) , MRI
APR 850hPa HIGH & Wind (1979-2003) , MRI
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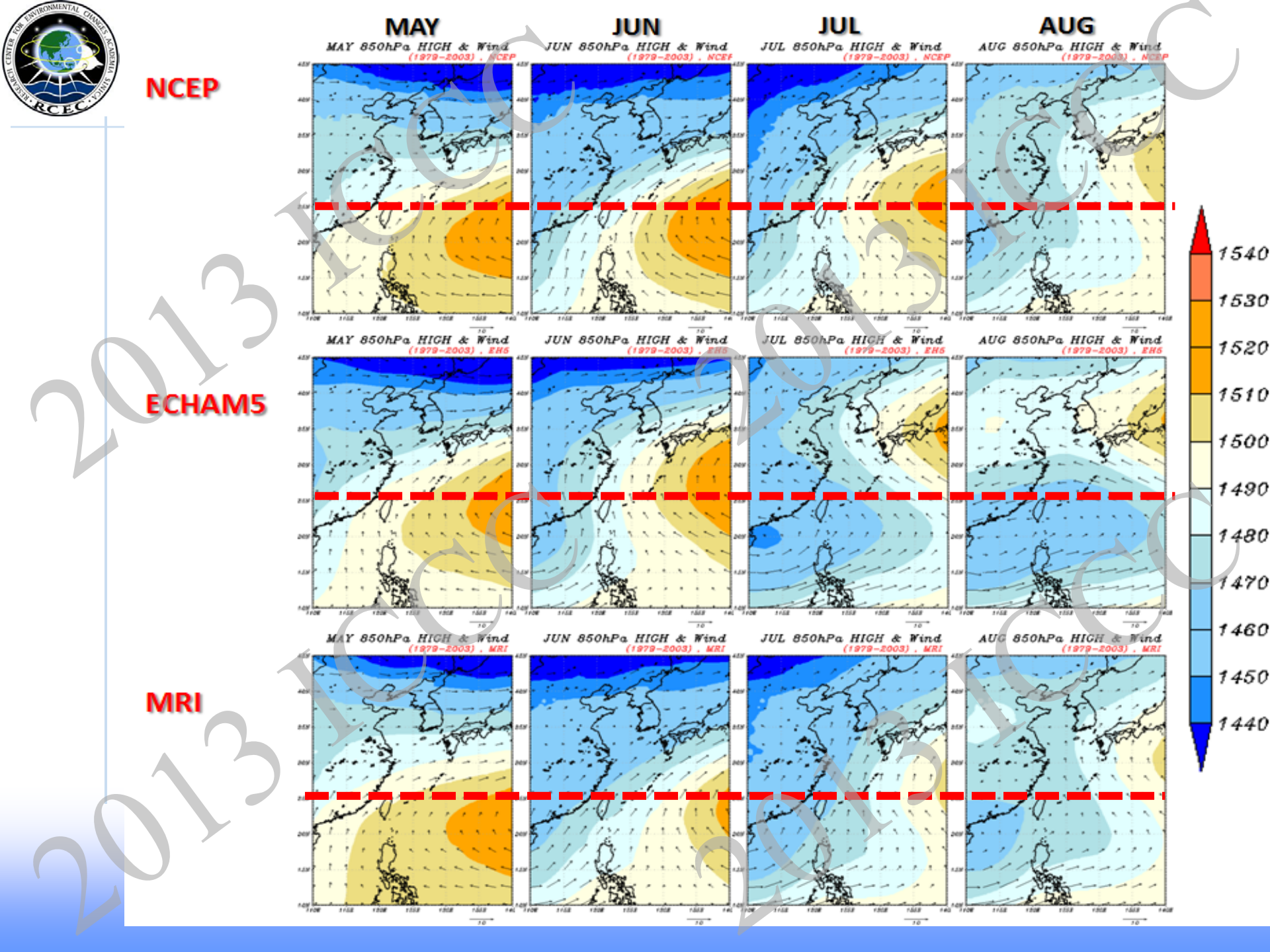
MAY
JUN
JUL
AUG
NCEP
ECHAM5
MRI
MAY 850hPa HIGH & Wind (1979-2003) , NCEP
JUN 850hPa HIGH & Wind (1979-2003) , NCEP
JUL 850hPa HIGH & Wind (1979-2003) , NCEP
AUG 850hPa HIGH & Wind (1979-2003) , NCEP
MAY 850hPa HIGH & Wind (1979-2003) , EH5
JUN 850hPa HIGH & Wind (1979-2003) , EH5
JUL 850hPa HIGH & Wind (1979-2003) , EH5
AUG 850hPa HIGH & Wind (1979-2003) , EH5
MAY 850hPa HIGH & Wind (1979-2003) , MRI
JUN 850hPa HIGH & Wind (1979-2003) , MRI
JUL 850hPa HIGH & Wind (1979-2003) , MRI
AUG 850hPa HIGH & Wind (1979-2003) , MRI
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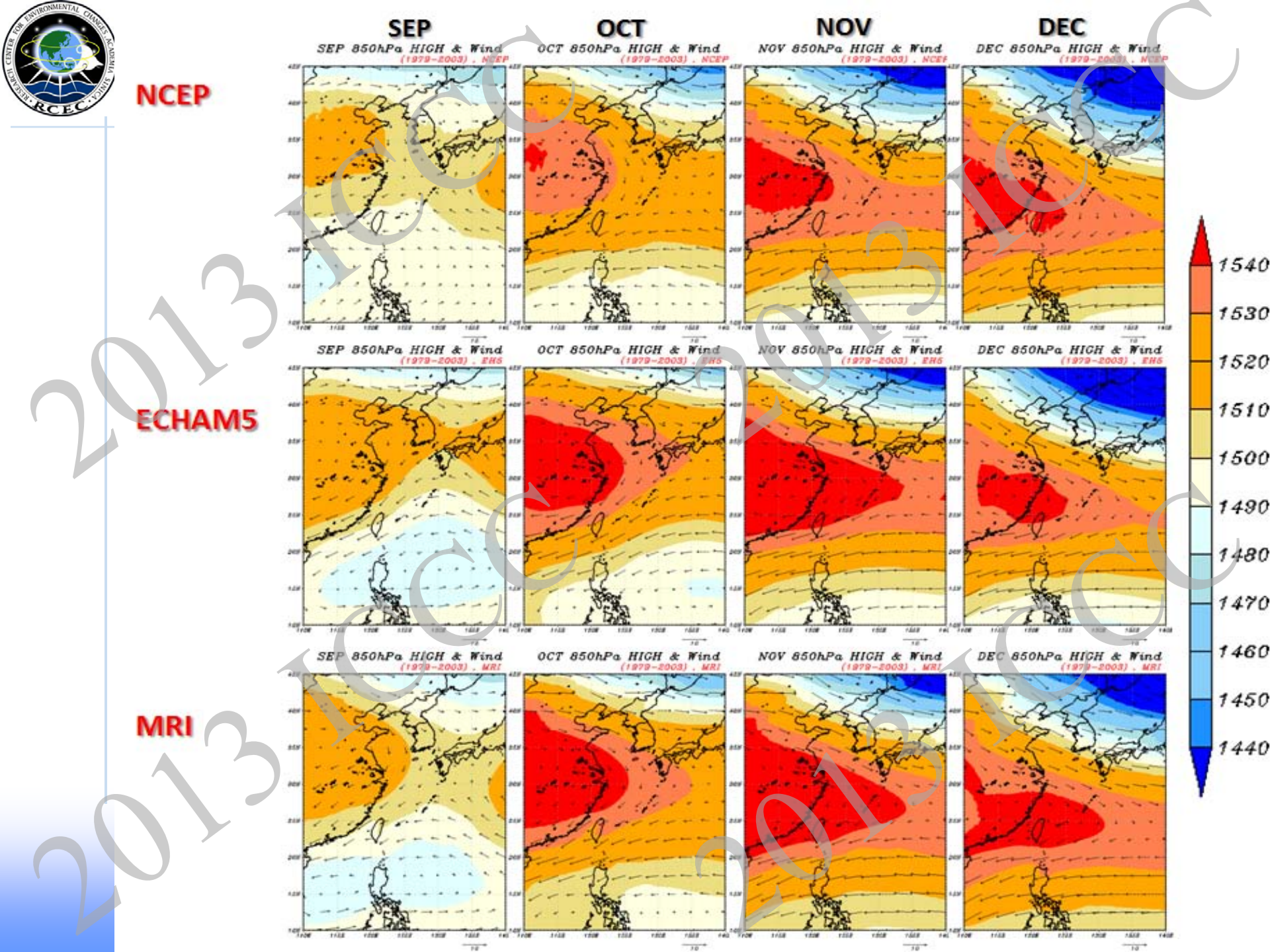
SEP
OCT
NOV
DEC
NCEP
ECHAM5
MRI
SEP 850hPa HIGH & Wind (1979-2003) , NCEP
OCT 850hPa HIGH & Wind (1979-2003) , NCEP
NOV 850hPa HIGH & Wind (1979-2003) , NCEP
DEC 850hPa HIGH & Wind (1979-2003) , NCEP
SEP 850hPa HIGH & Wind (1979-2003) , EH5
OCT 850hPa HIGH & Wind (1979-2003) , EH5
NOV 850hPa HIGH & Wind (1979-2003) , EH5
DEC 850hPa HIGH & Wind (1979-2003) , EH5
SEP 850hPa HIGH & Wind (1979-2003) , MRI
OCT 850hPa HIGH & Wind (1979-2003) , MRI
NOV 850hPa HIGH & Wind (1979-2003) , MRI
DEC 850hPa HIGH & Wind (1979-2003) , MRI
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1460
1450
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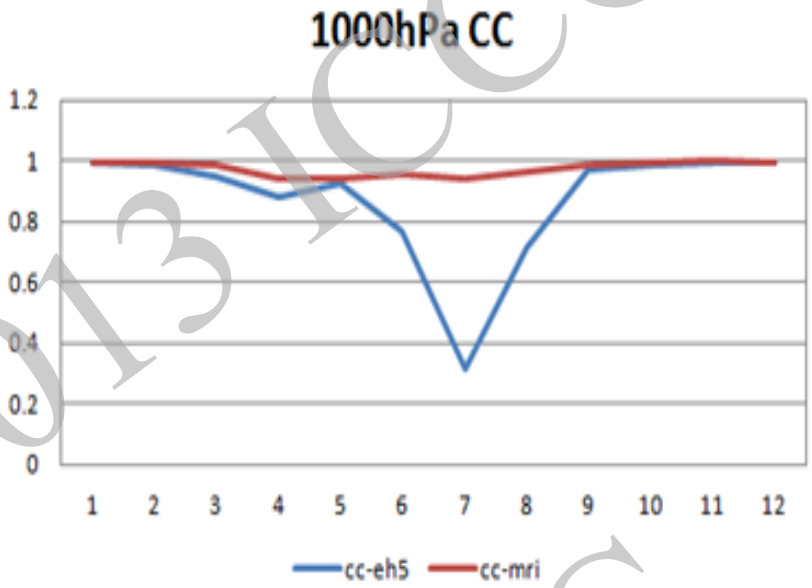
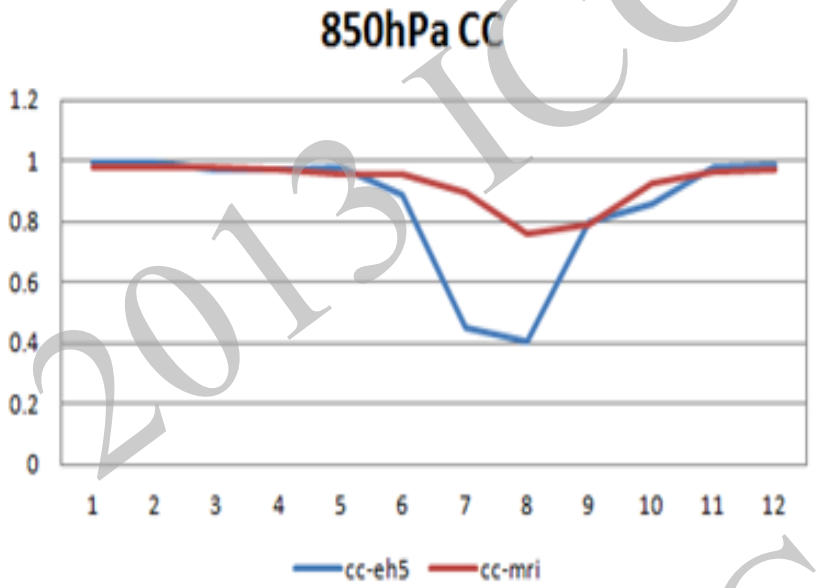
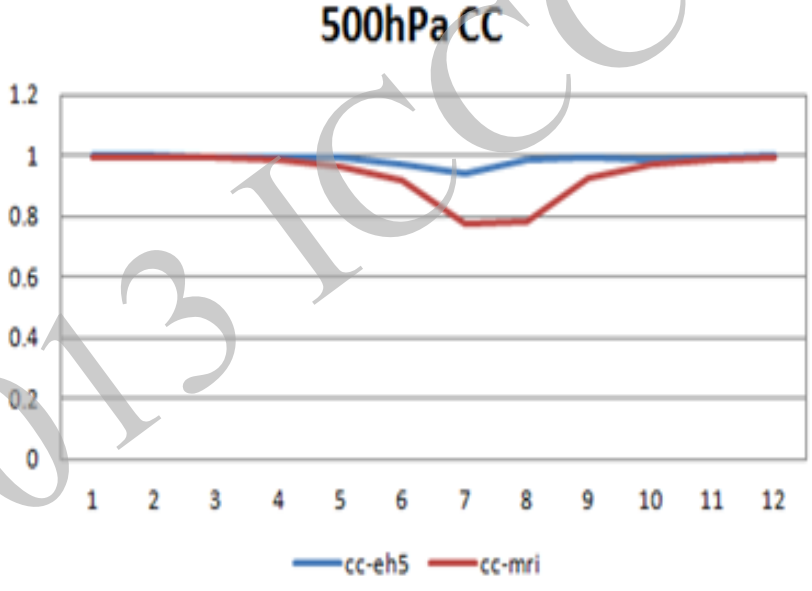
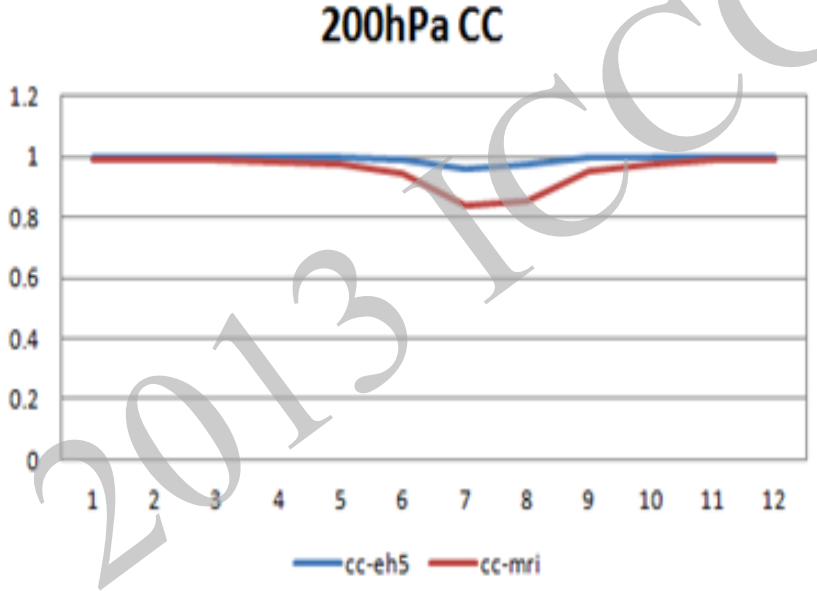
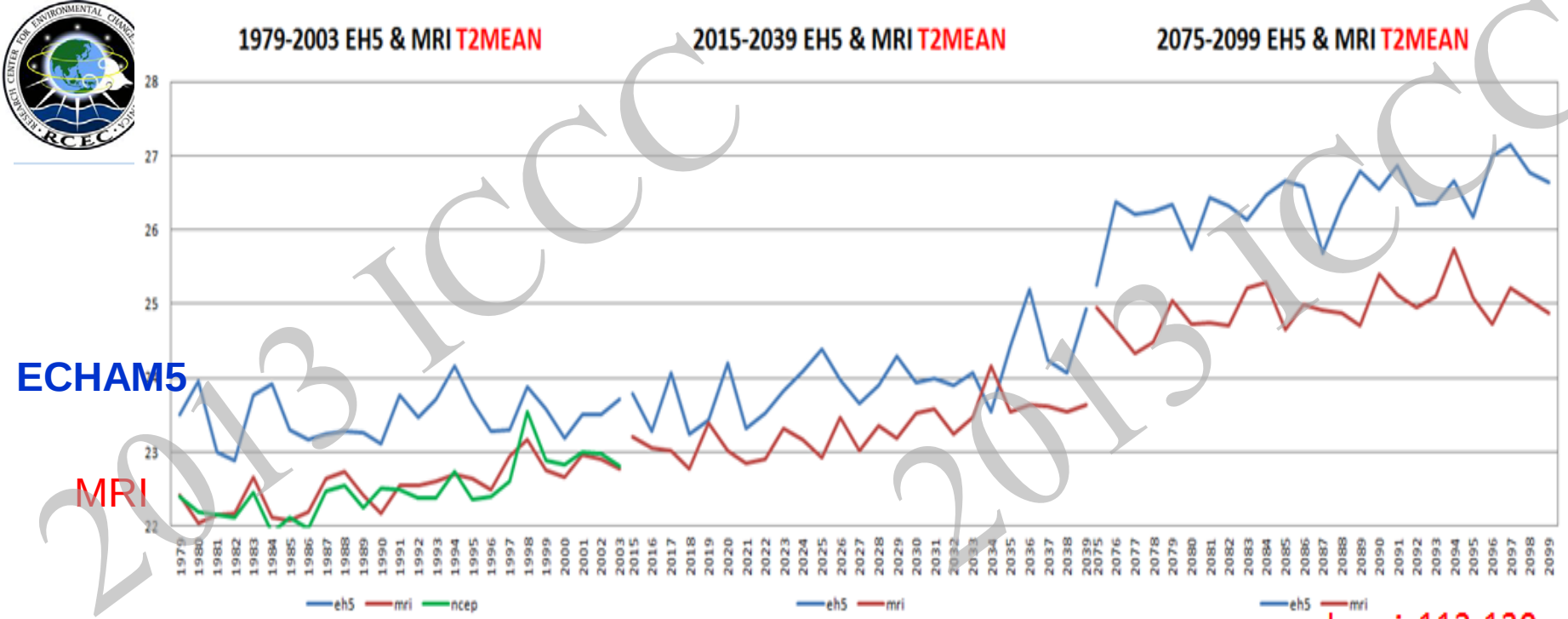
NCEP& MRI、ECHAM5 相關係數比較



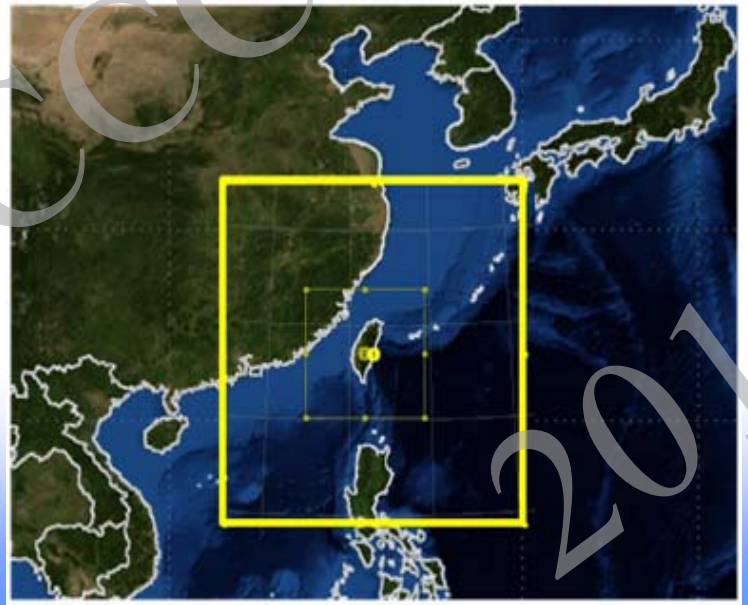






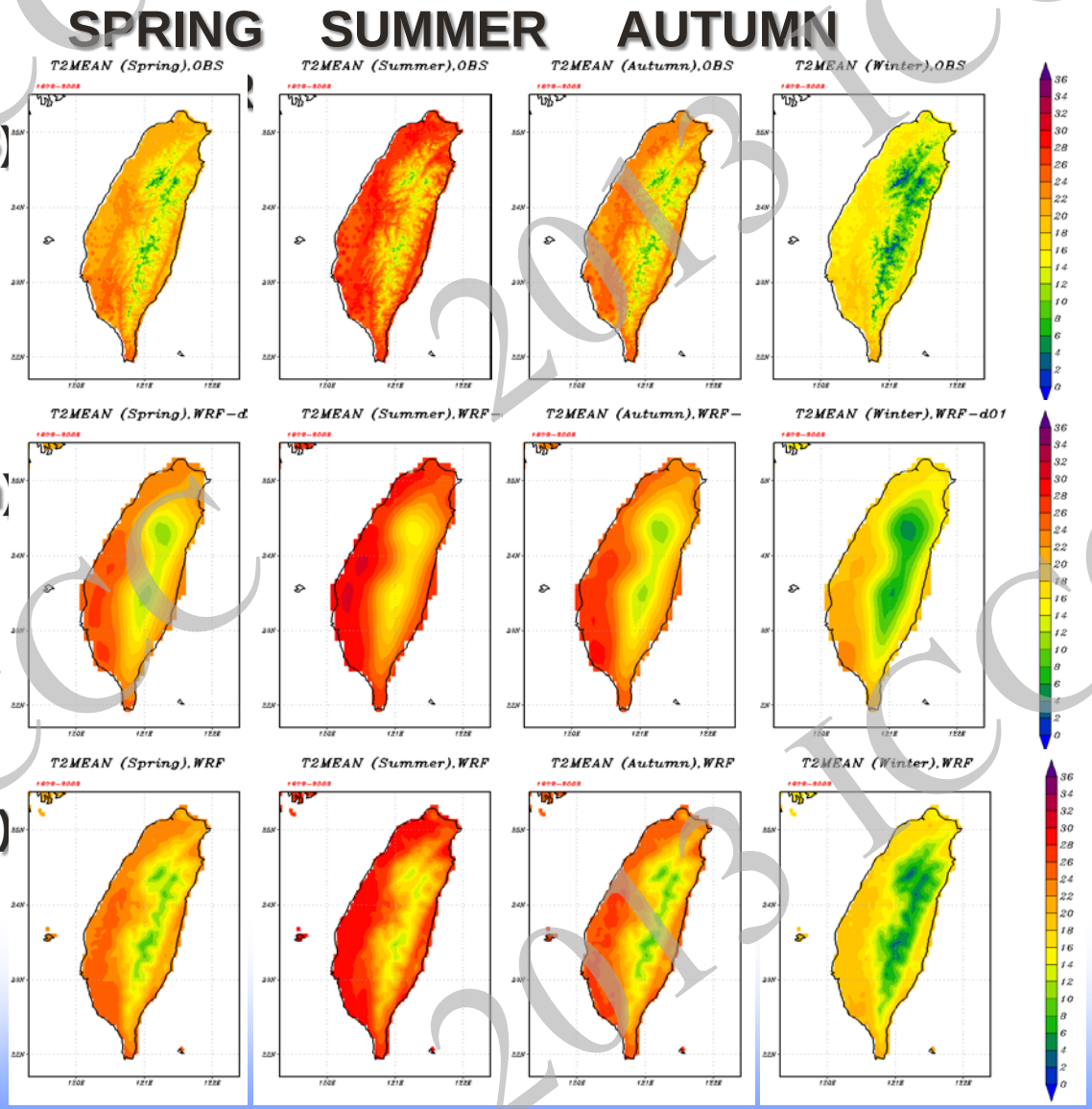


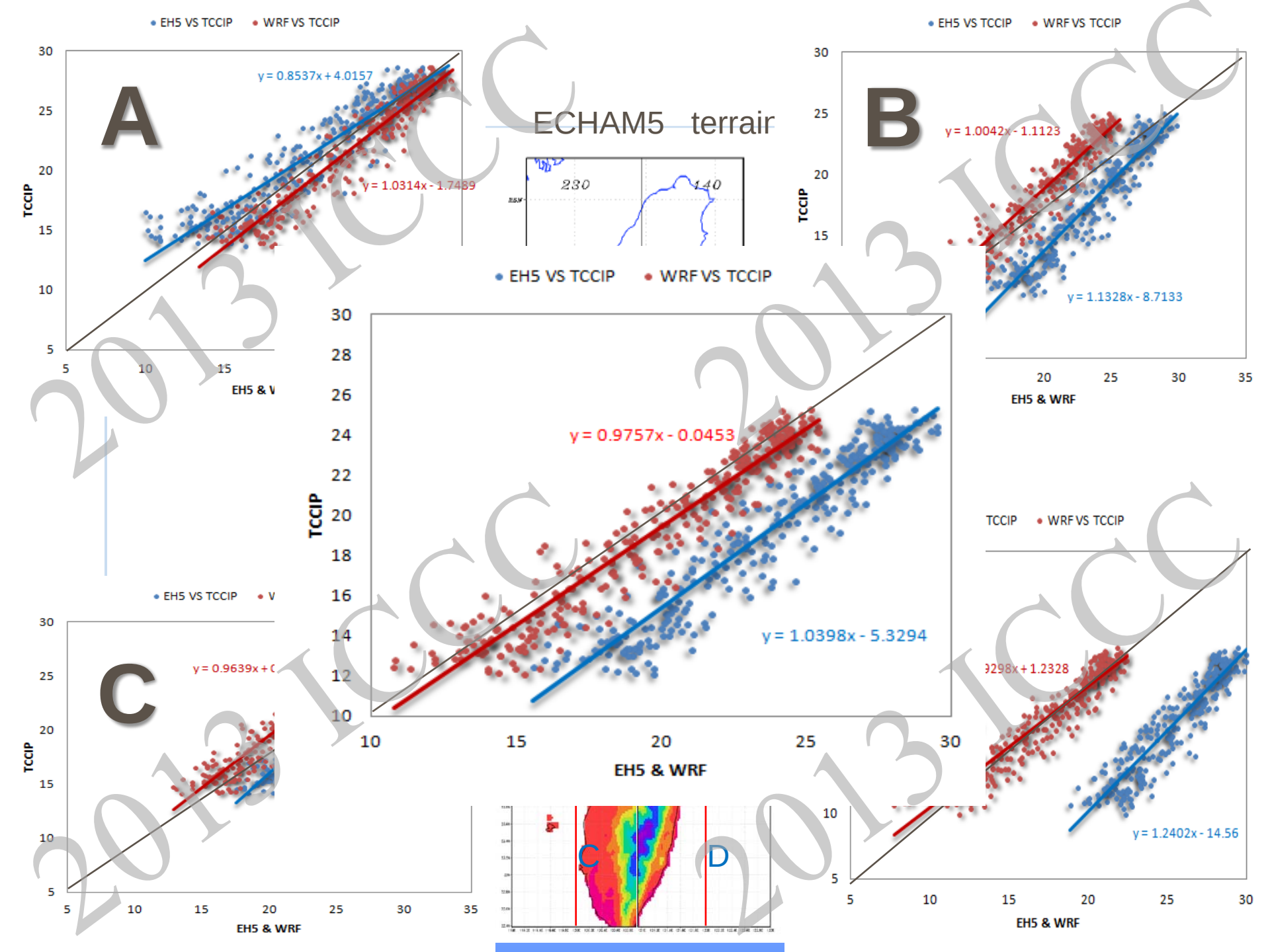
ECHAM5:~200 Km
MRI:20 Km



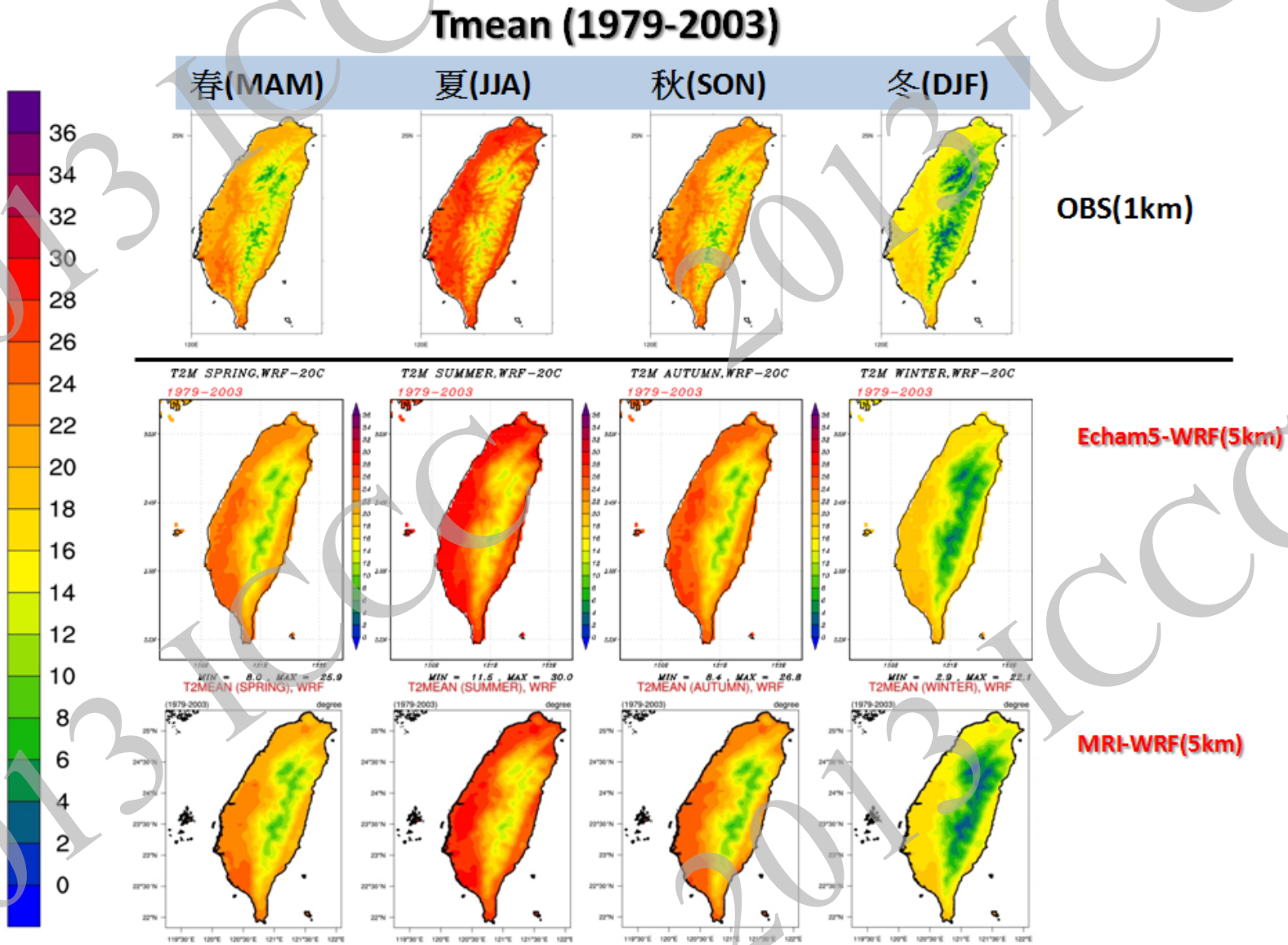
動力降尺度
氣溫推估比較

ECHAM5 dynamical downscaling : Temperature evaluation

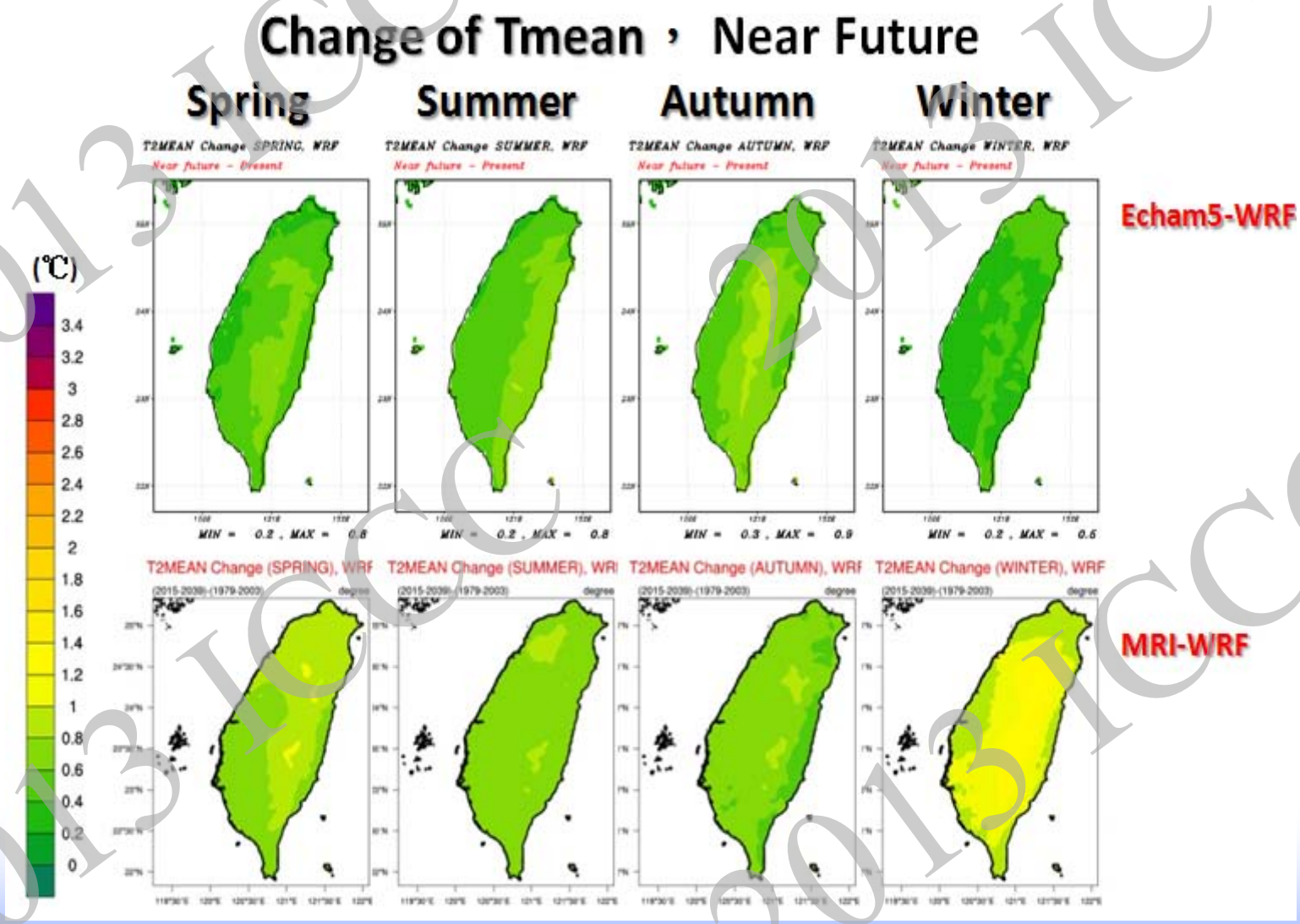



EH5 VS TCCIP
WRF VS TCCIP
A
y = 0.8537x + 4.0157
y = 1.0314x - 1.7489
TCCIP
EH5 & W
B
y = 1.0042x - 1.1123
y = 1.1328x - 8.7133
EH5 & WRF
ECHAM5 terrair
230
140
C
y = 0.9639x + 0
D
y = 0.9757x - 0.0453
y = 1.0398x - 5.3294
y = 1.2402x - 14.56
2013 ICCC

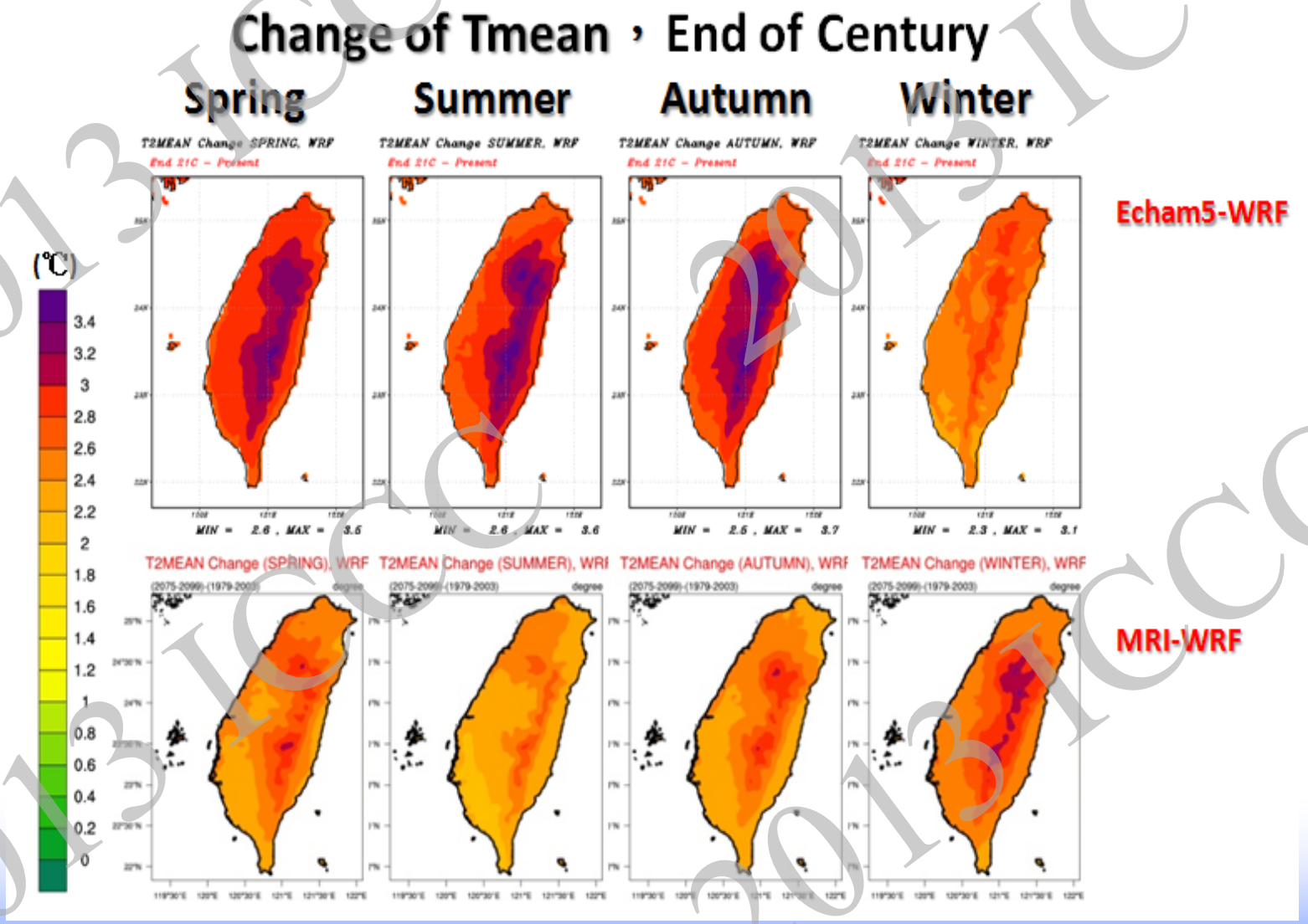
Present (1979-2003)



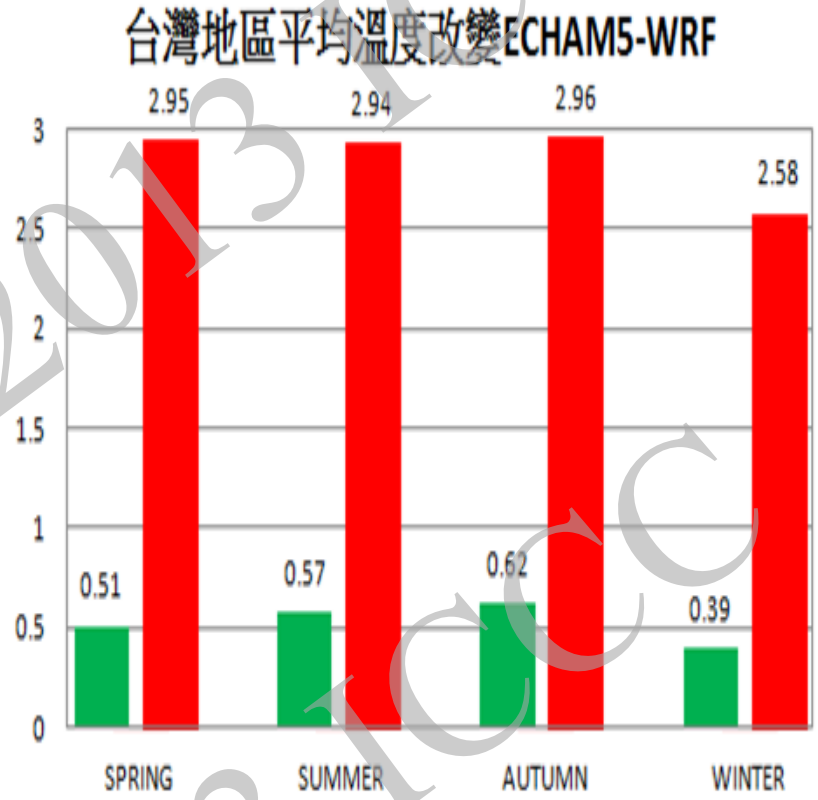
Temperature difference (Near Future –Present)

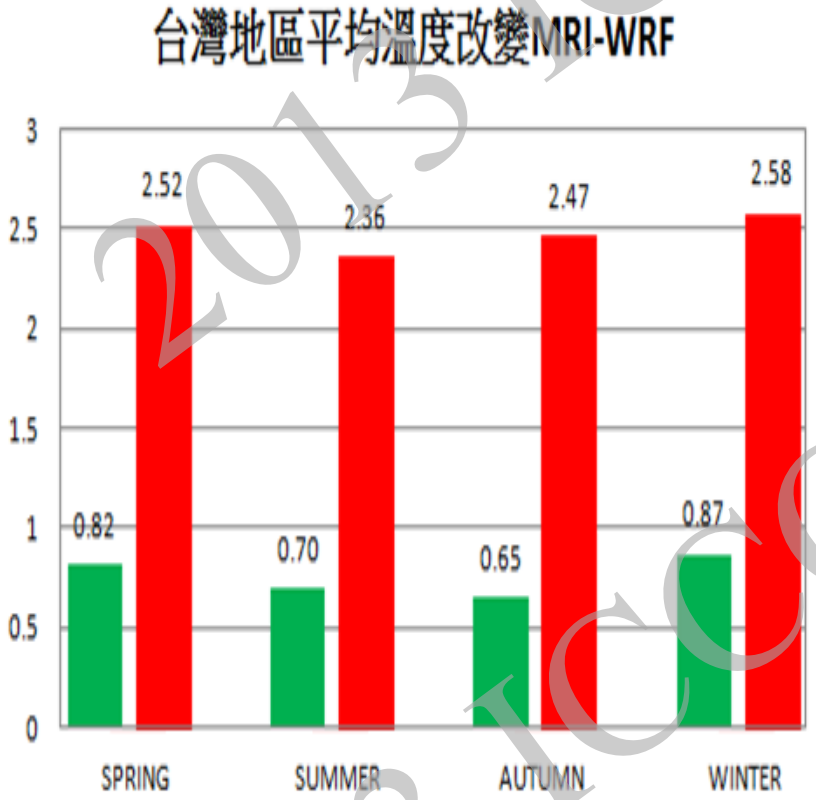


Temperature Difference (End of Century-Present)



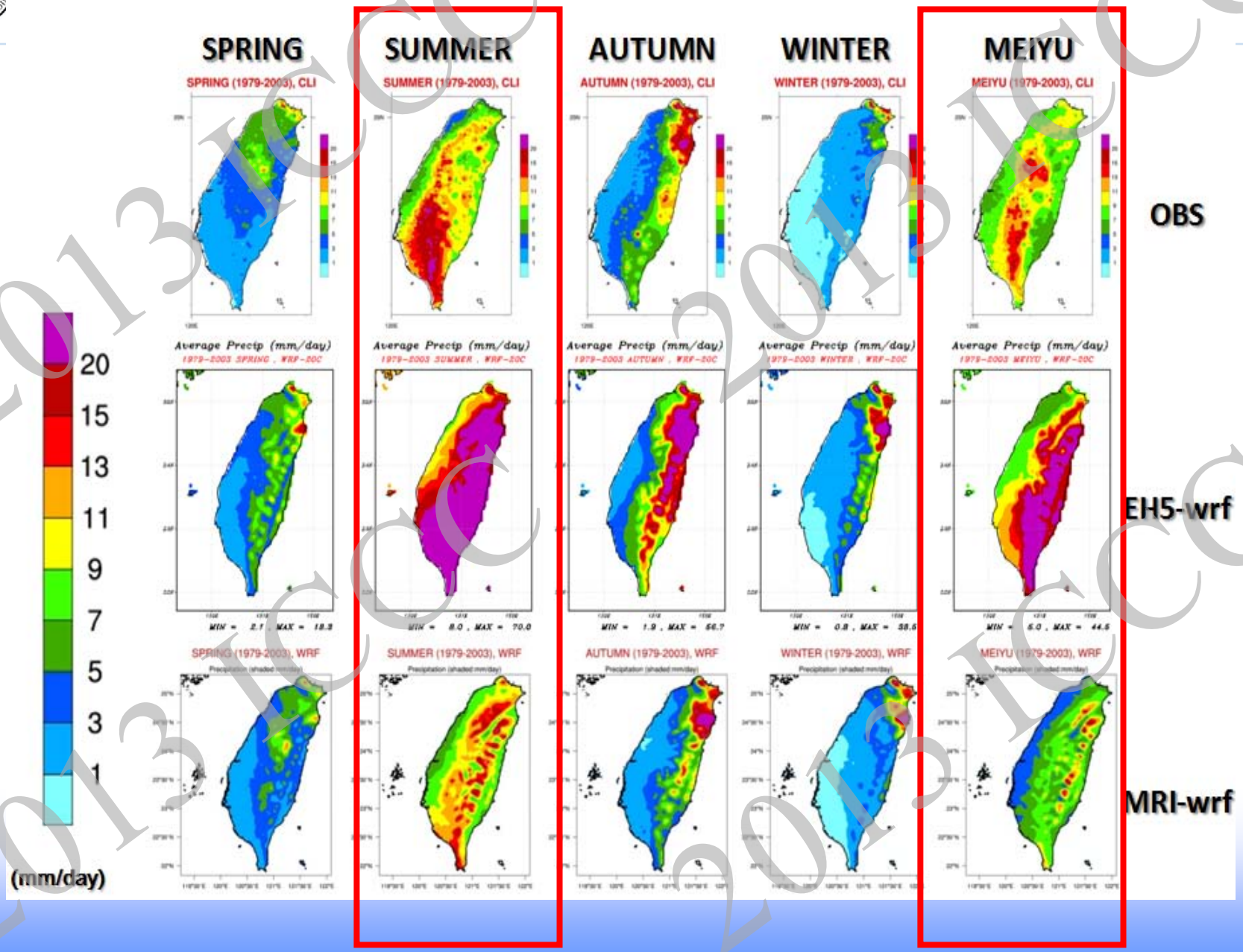
Temperature Difference Summary



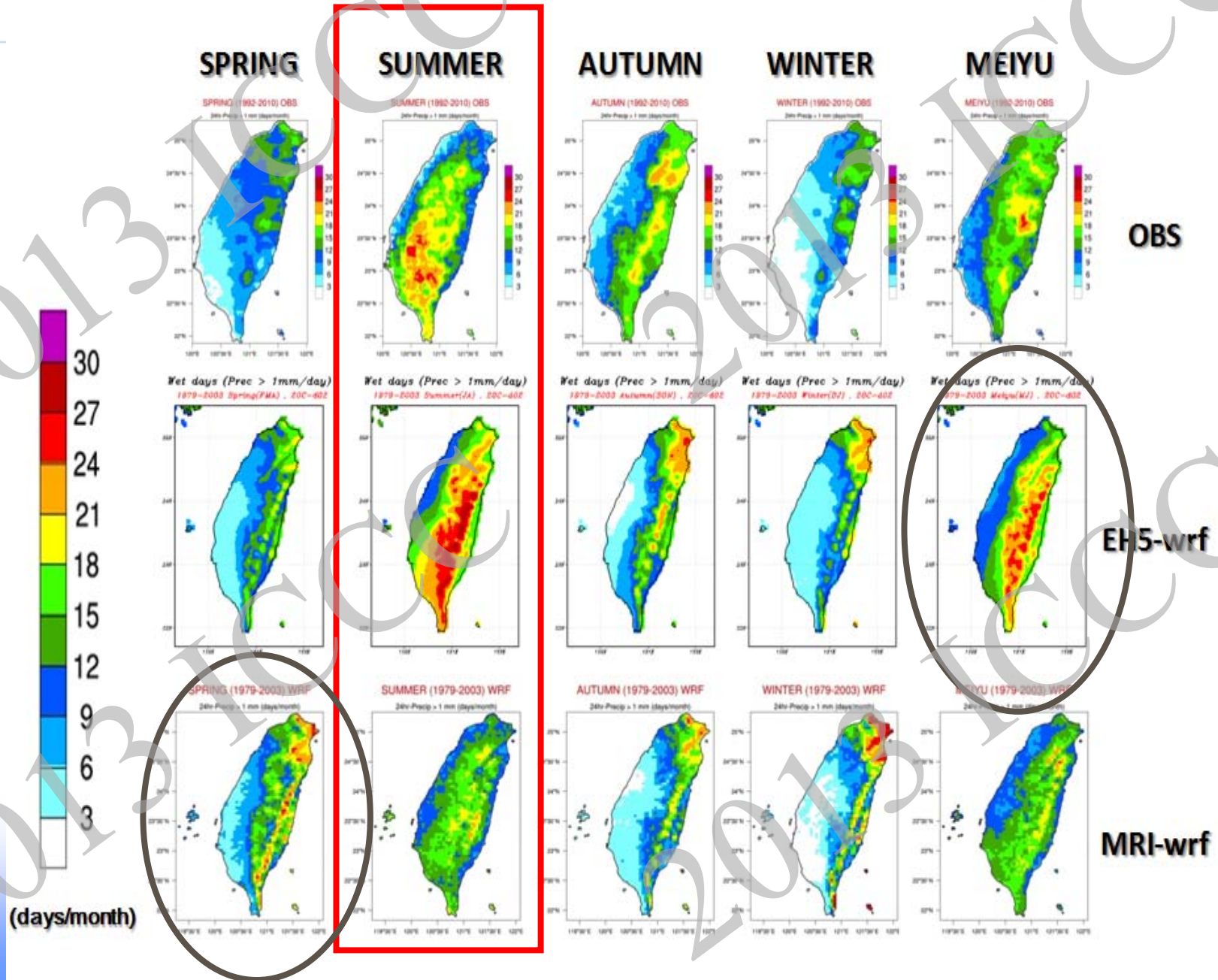


動力降尺度
降雨推估比較

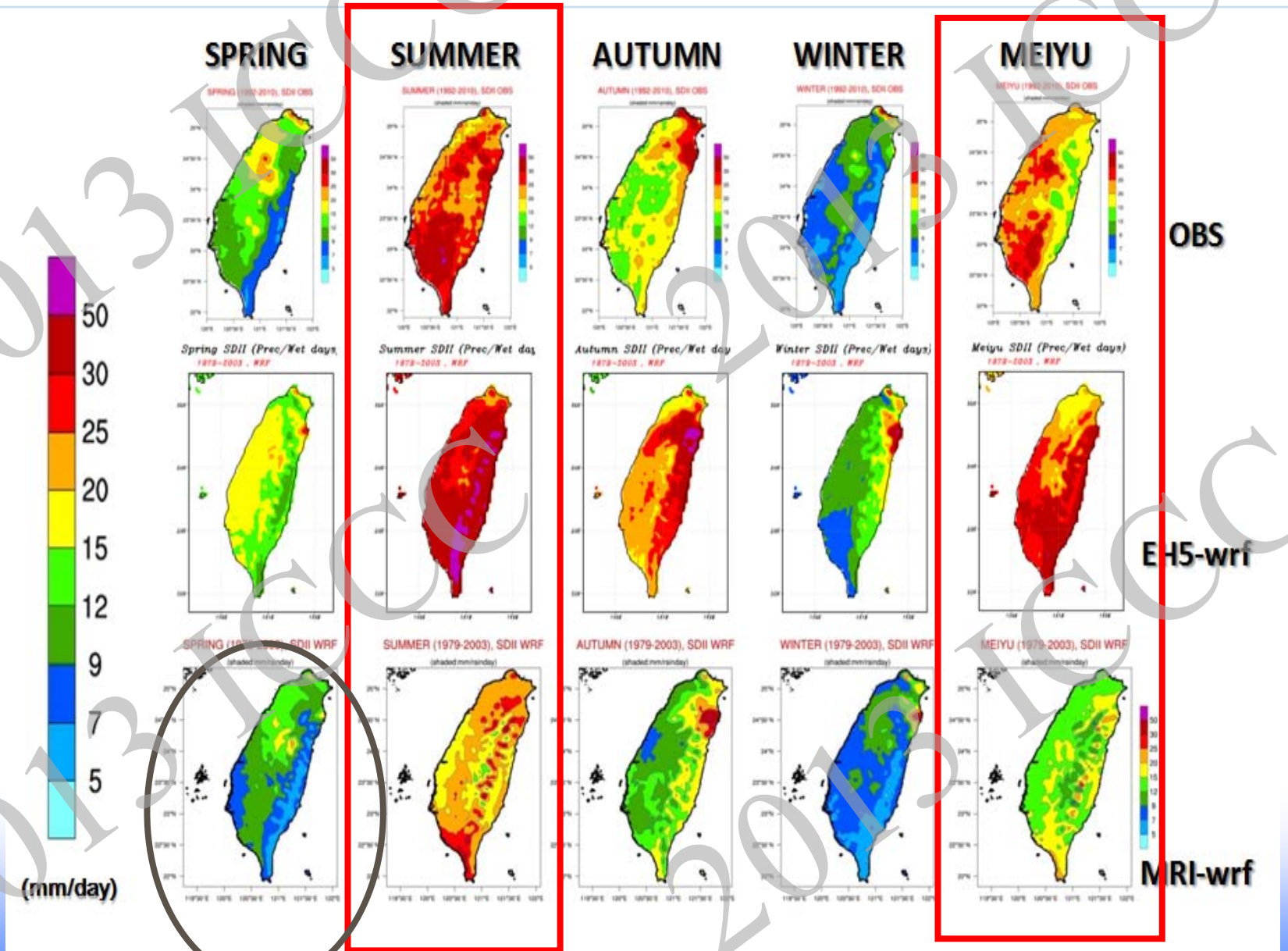
Seasonal Mean Precipitation (1979-2003)



Wet Day (Daily Precipitation > 1mm) --- Present (1979-2003)

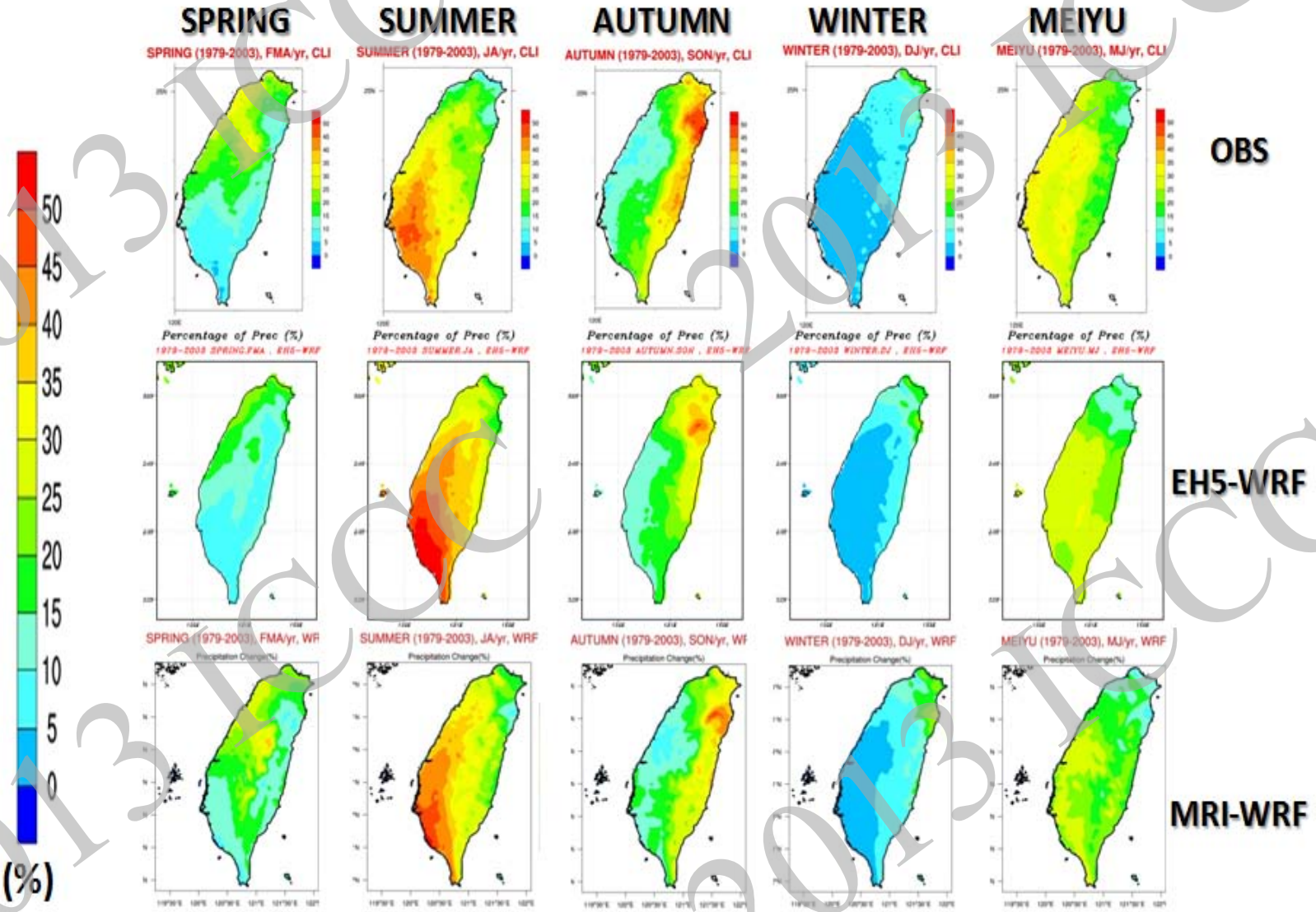


SDII (Simple Day Intensity Index) (1979-2003)



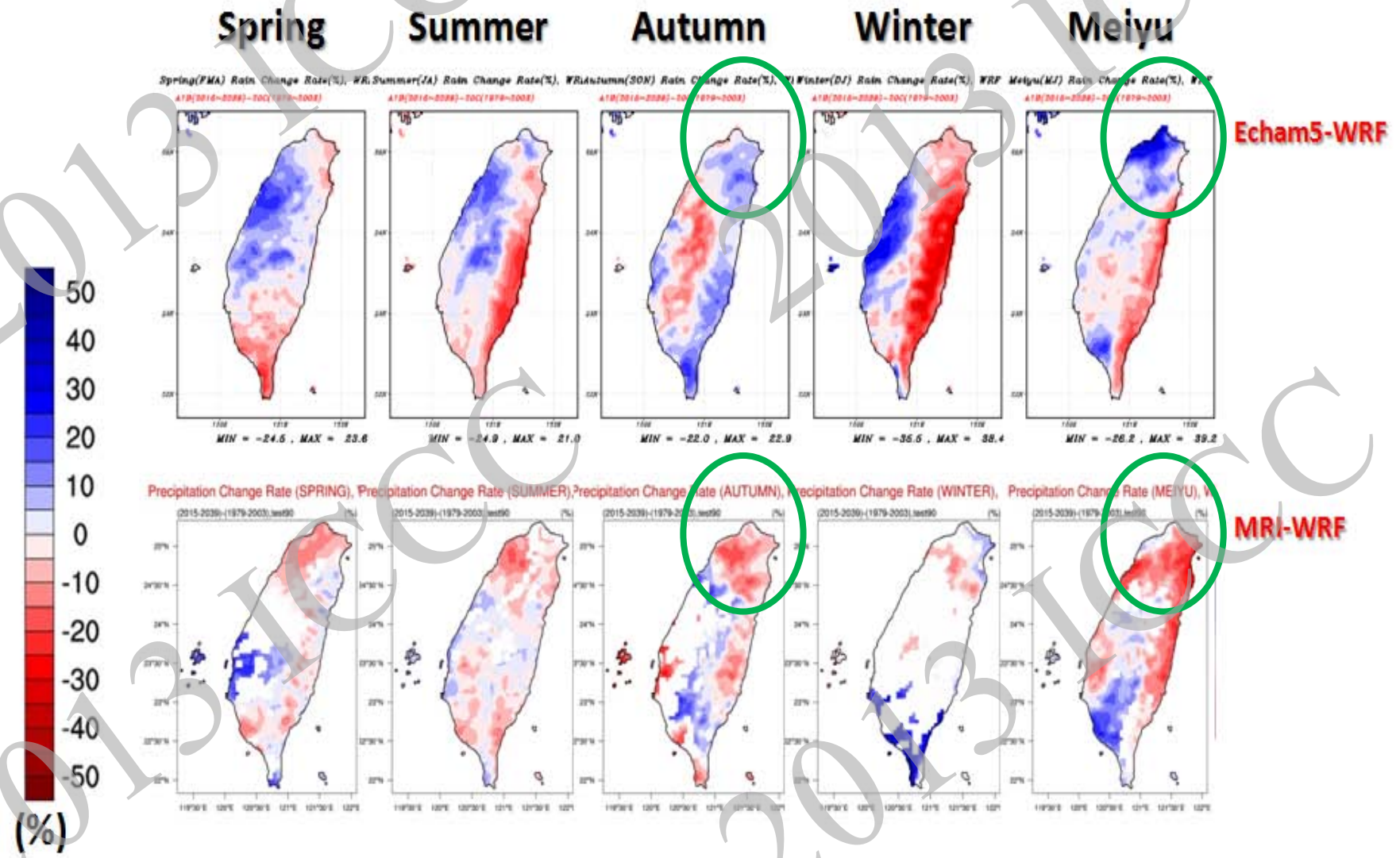
Percentage of Precipitation (%)

(1979-2003)



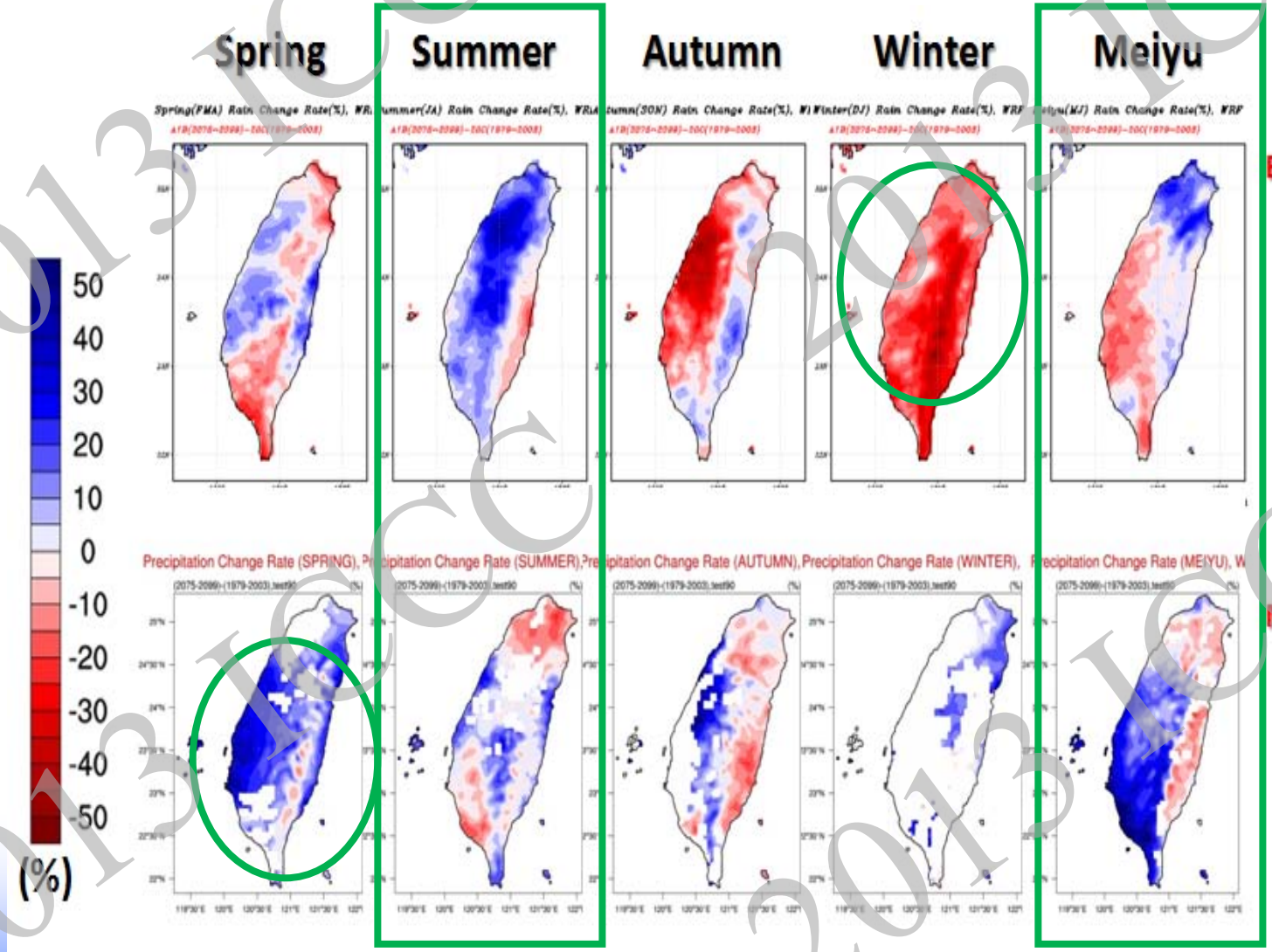
Precipitation Change Rate (%) WRF

(Near future – Present)/ Present



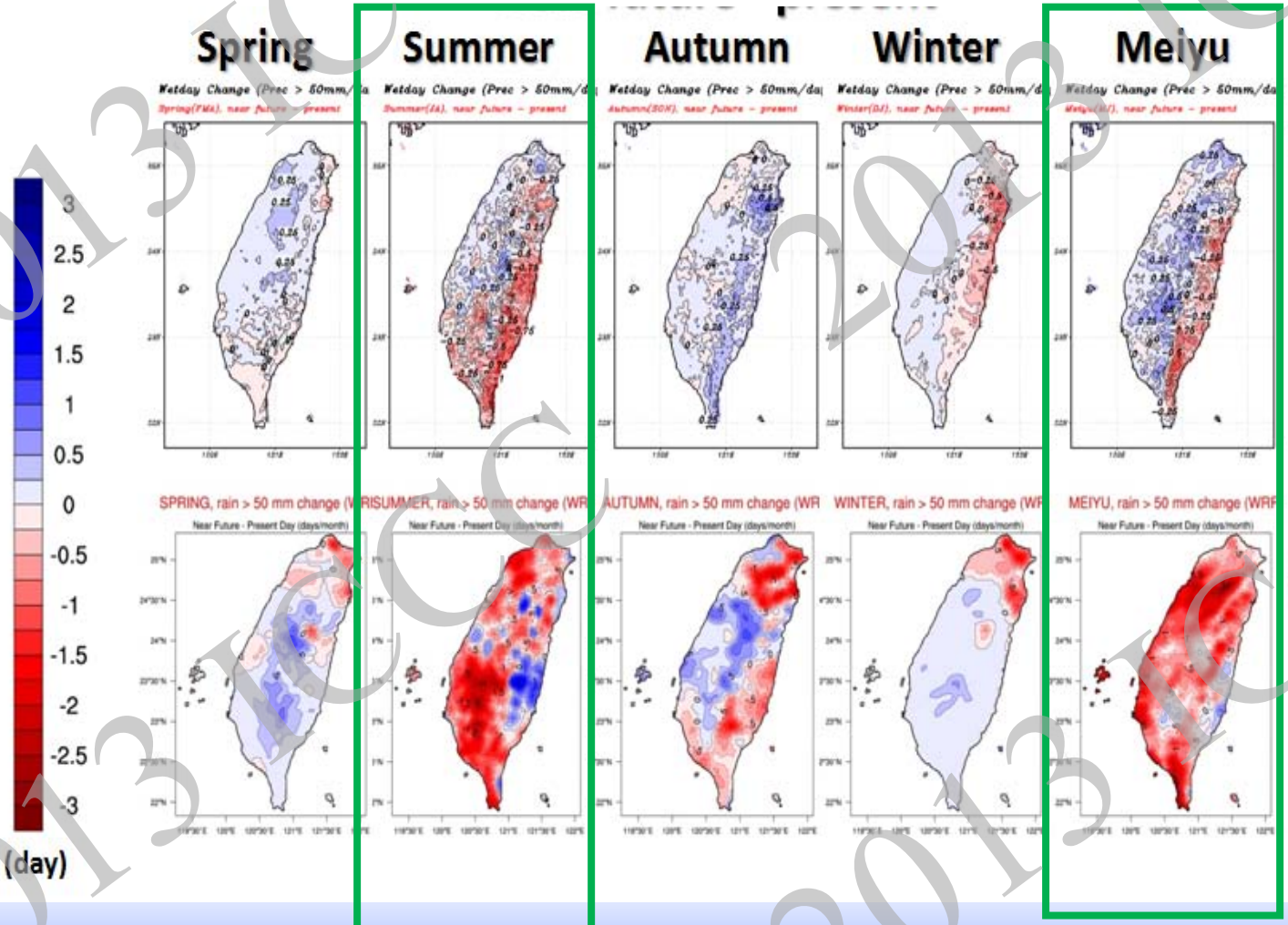
Precipitation Change Rate (%) WRF

(End 21C- Present)/ Present

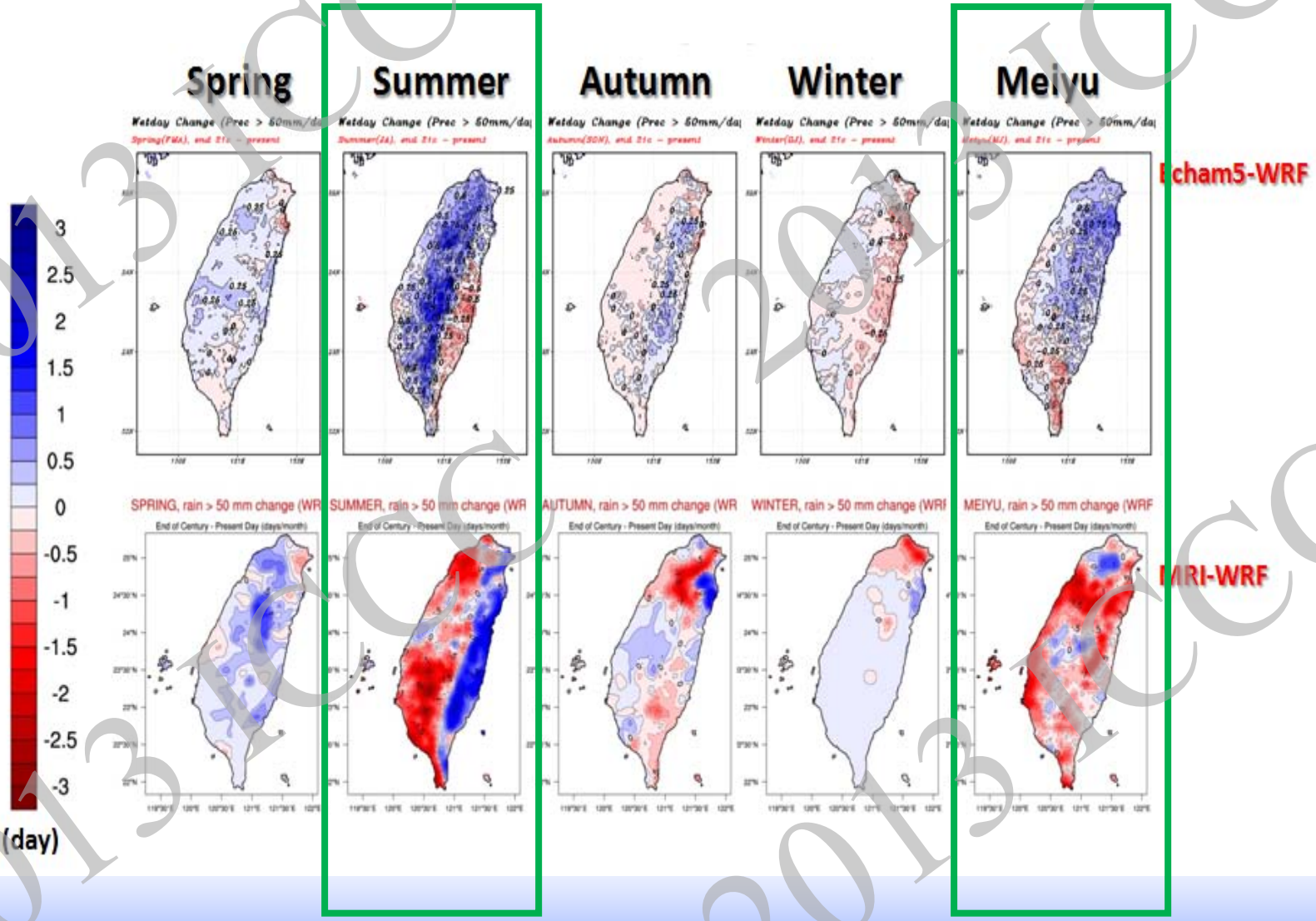


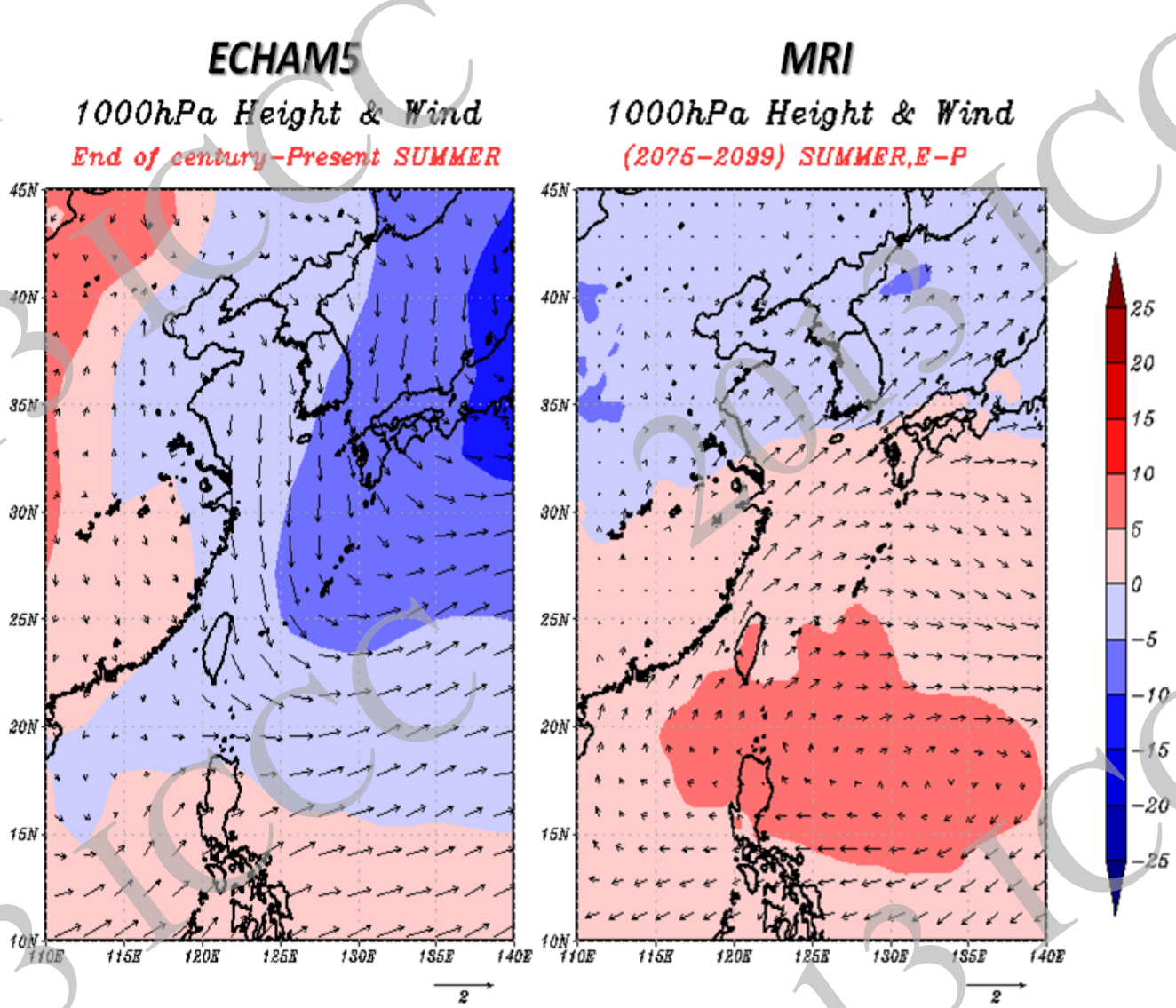
Extremely Day Change (Daily Precipitatin > 50mm) , WRF

Near future - present



Extremely Day Change (Daily Precipitatin > 50mm) , WRF
End of century - present

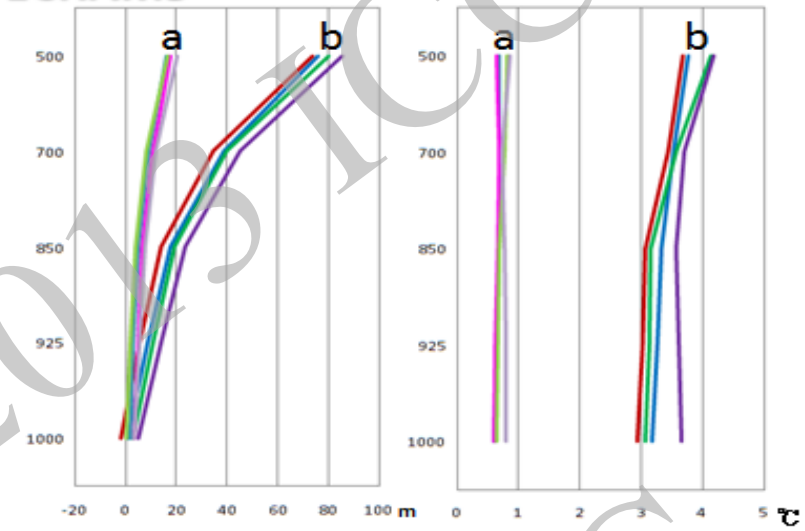




1000hPa ECHAM5與MRI高度場與風場變化(世紀末時期減現在時期)，左邊為ECHAM5，右邊為MRI。冷色系表示世紀末時期低估，暖色系表示世紀末時期高估。

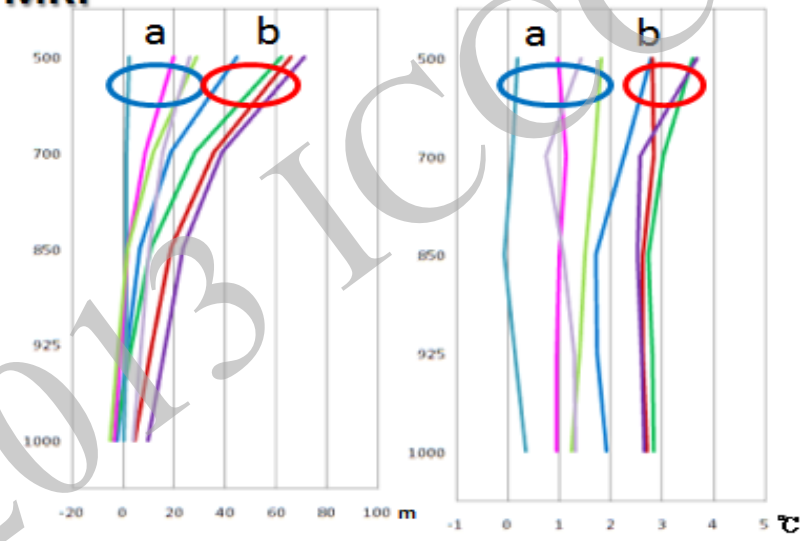
ECHAM5

Lon : 110-140 Lat : 10-45

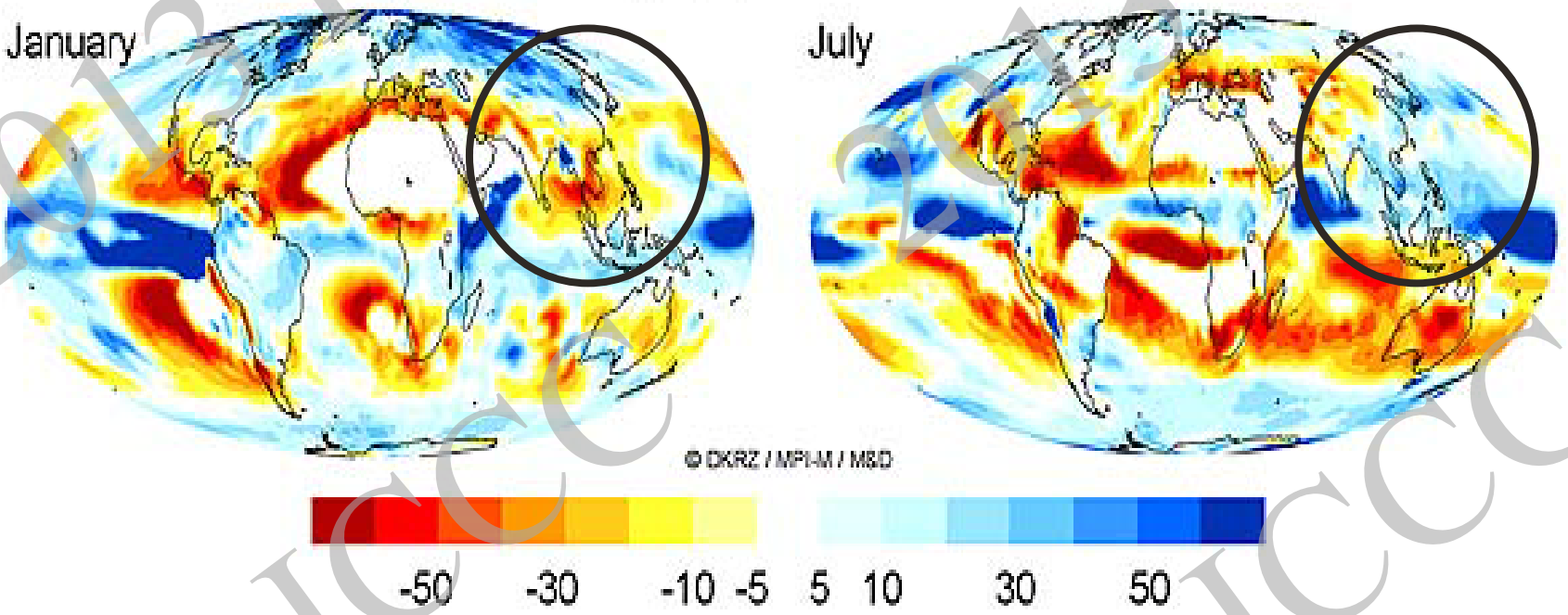


Height Tmp

MRI



SPRING(E-P)
SUMMER(E-P)
AUTUMN(E-P)
WINTER(E-P)
SPRING(N-P)
SUMMER(N-P)
AUTUMN(N-P)
WINTER(N-P)


A1B: Mean Precipitation Change [%] for 2071-2100 compared with 1961-1990
January
July
© DKRZ / MPI-M / M&D
-50
-30
-10
-5
5
10
30
50

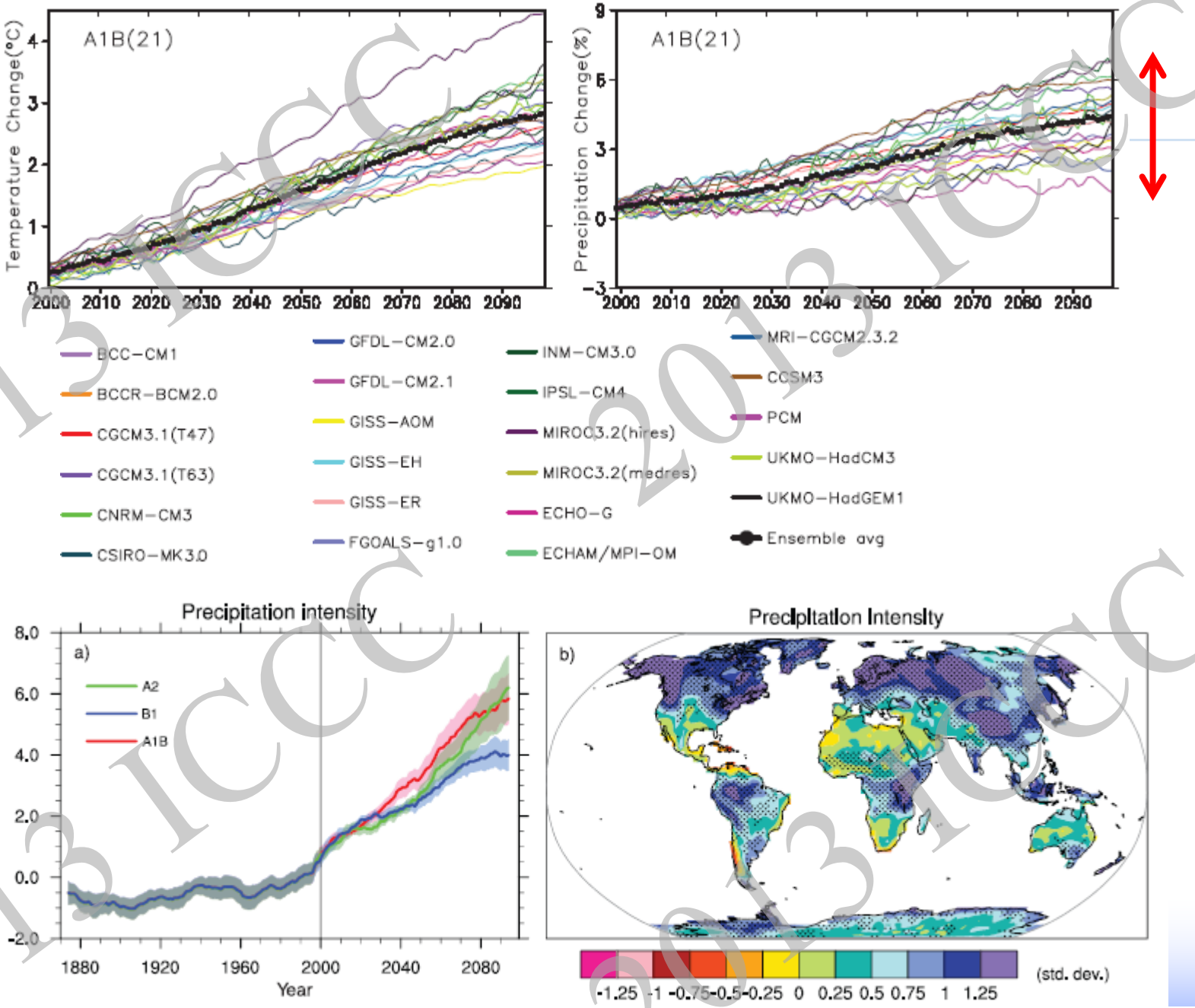
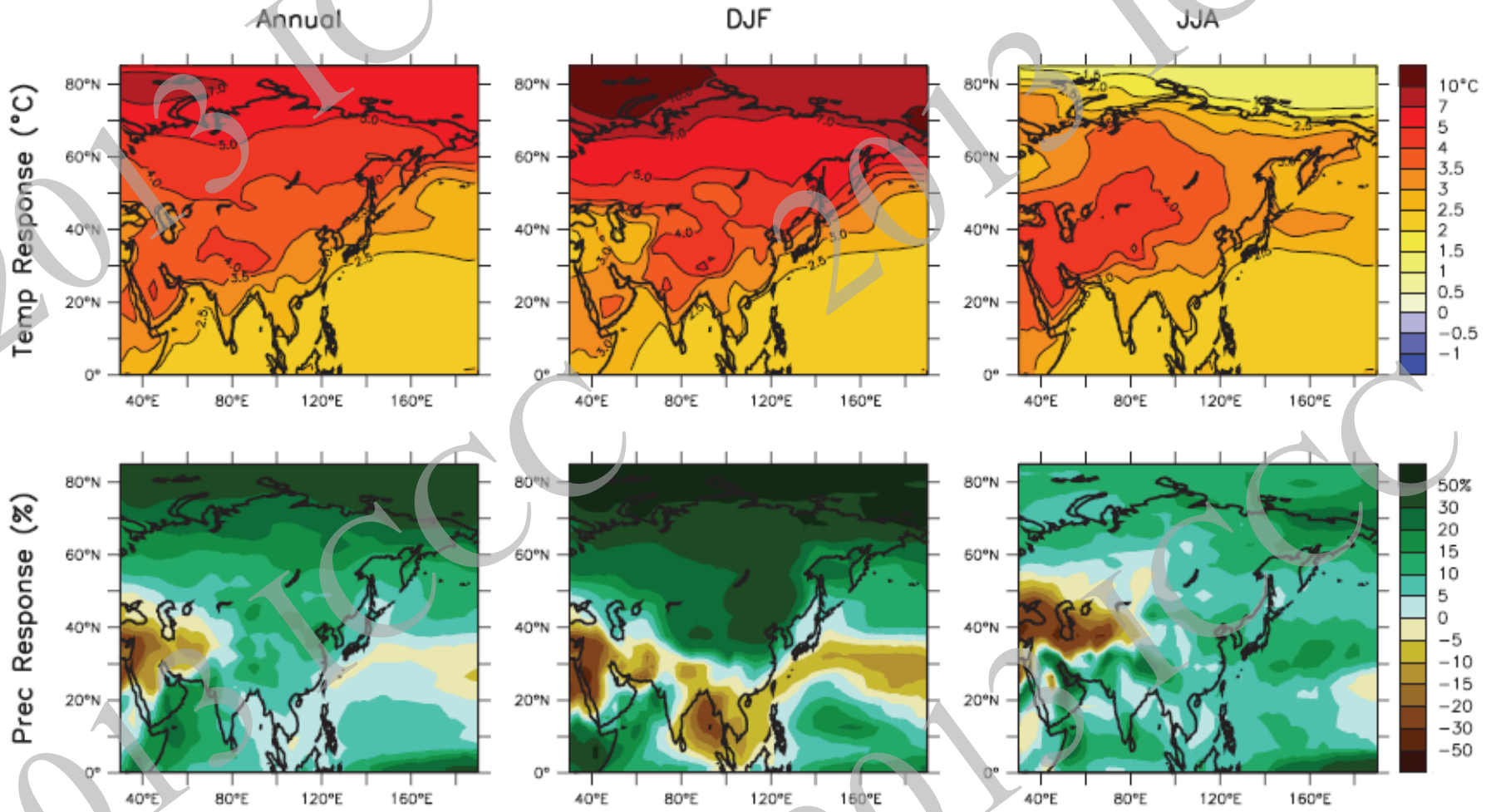


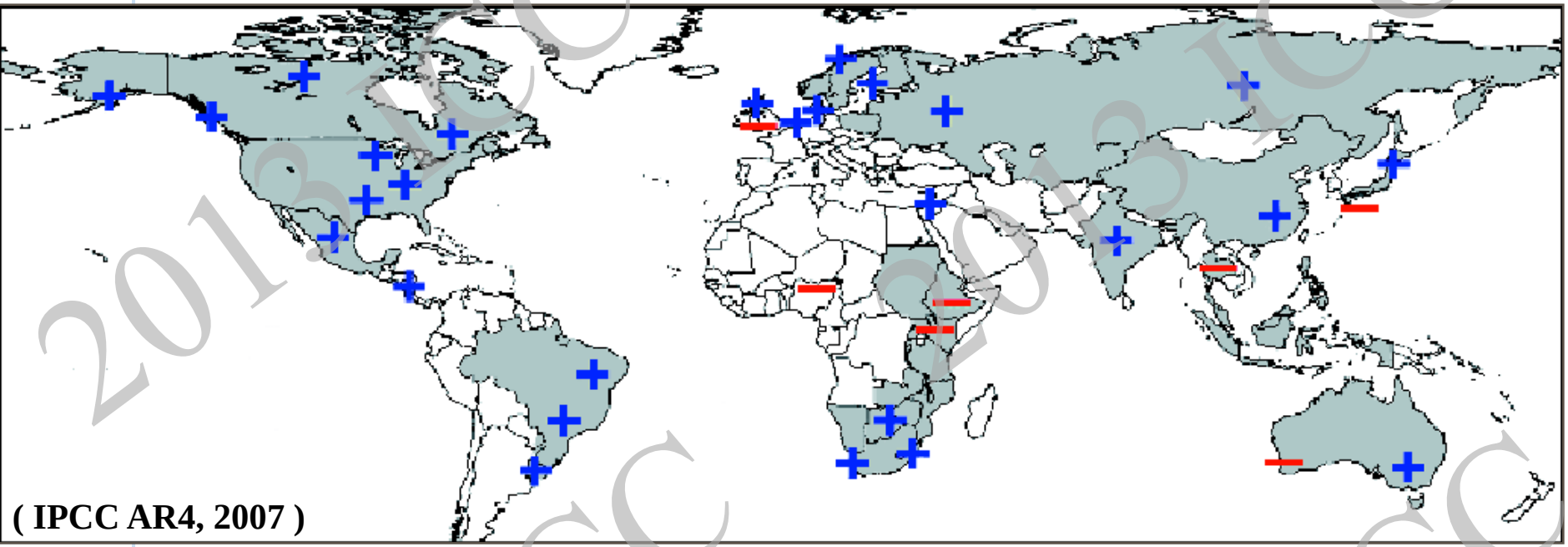
Figure 10.18. *Changes in extremes based on multi-model simulations from nine global coupled climate models, adapted from Tebaldi et al. (2006). (a) Globally averaged changes in precipitation intensity (defined as the annual total precipitation divided by the number of wet days) for a low (SRES B1), middle (SRES A1B) and high (SRES A2) scenario. (b) Changes in spatial patterns of simulated precipitation intensity between two 20-year means (2080–2099 minus 1980–1999) for the A1B scenario. (c) Globally aver-*

Summary

- 高度場與NCEP reanalysis 資料比較(未降尺度):
  - 以850 hPa 高度場為例, MRI 在夏季偏弱, 冬季偏強的趨勢,
  - 以氣流型態而言, 主要差異在夏季 (6, 7,8 月), MRI與NCEP 較為接近, ECHAM5 太平洋高壓脊則較為北偏(5-10 度)
- ECHAM5 及MRI 動力降尺度, 確可改善台灣區域尺度之模擬推估結果
- 溫度:平均而言, 台灣區域
  - 近未來ECHAM5 推估增溫0.52 度, MRI 增溫0.76 度
  - 世紀末, ECHAM5 推估增溫2.82 度, MRI 增溫2.48 度
- 雨量:
  - 整體而言, ECHAM5 推估降雨量有高估的現象, 而MRI 雨量在夏季及梅雨季則為低估
  - 兩模式降雨推估並不一致, 以極端降雨為例, ECHAM5推估極端降雨日數之變化, 在世紀末, 夏季,台灣西半部是增加; 梅雨季北部降雨日為增加, 相反的, 在MRI 卻與上述相反



Temperature and precipitation changes over Asia from the MMD-A1B simulations.



Changes in heavy precipitation frequencies are always greater than changes in precipitation total and in some regions, an increase in heavy and/or very heavy precipitation occurred while no change or even a decrease in precipitation totals was observed

大雨日	春季	夏季	秋季	冬季	梅雨季	近未來	春季	夏季	秋季	冬季	梅雨季
北部	↑	↑	↑	↑	↑		↑	↓	↓	↓	↓
中部	↑	↑	↑	↑	↑		↑	↓	↑	↑	↓
南部	↓	↓	↑	↑	↑		↑	↓	↓	↑	↓
東部	↑	↓	↑	↓	↓		↑	↑	↓	↑	↓
						世紀末					
北部	↑	↑	↓	↑	↑		↑	↓	↓	↓	↑
中部	↑	↑	↓	↑	↑		↑	↓	↑	↑	↑
南部	↑	↑	↓	↑	↓		↑	↓	↑	↑	↓
東部	↑	↓	↑	↓	↑		↑	↑	↑	↑	↓

大雨日分佈的情況

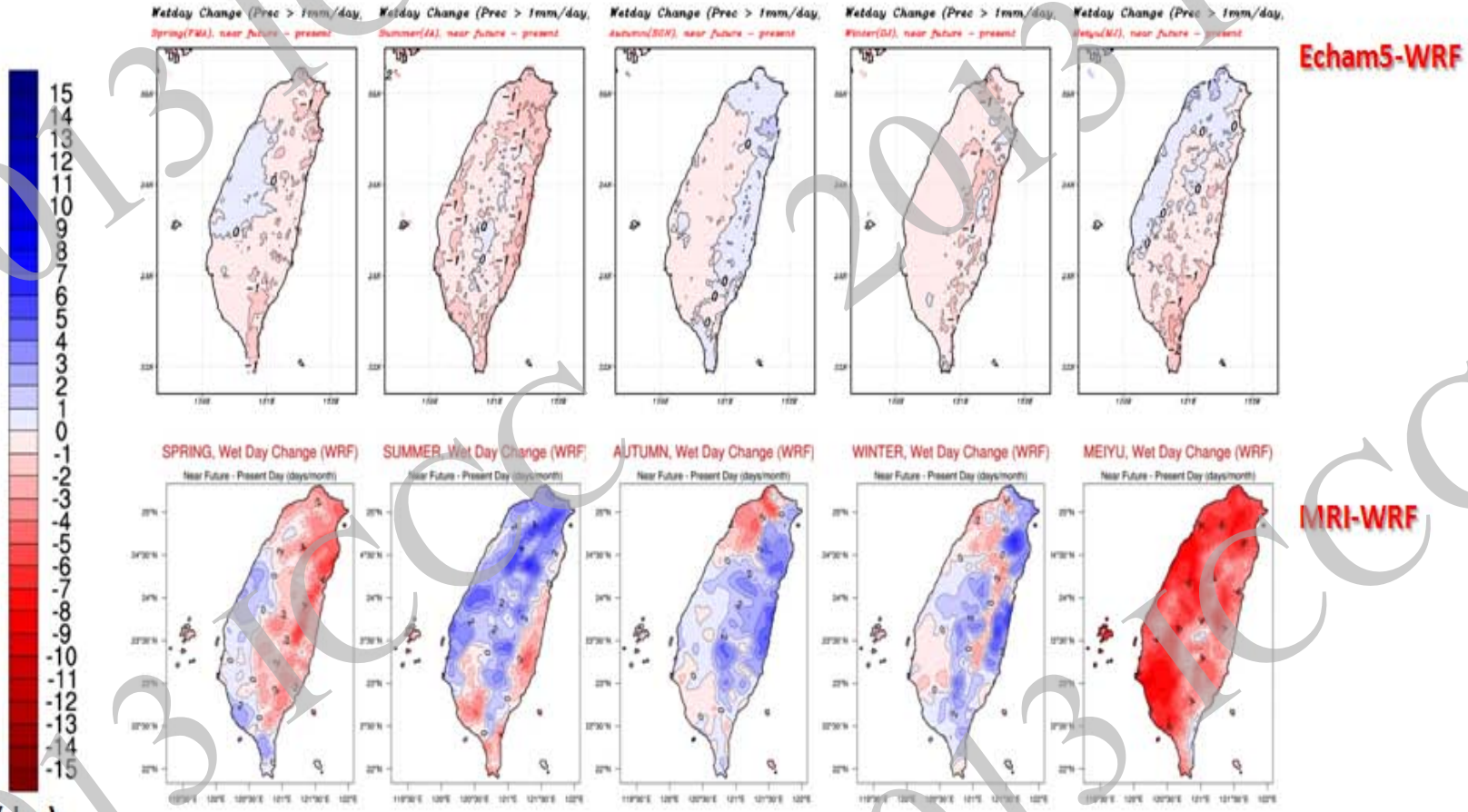
	ECHAM5-WRF					MRI-WRF			
日溫差變化	春季	夏季	秋季	冬季	近未來	春季	夏季	秋季	冬季
北部	↓	↓	↓	↑		↑	↑	↑	↑
中部	↓	↓	↑	↓		↑	–	↑	↓
南部	↑	↑	↓	↑		↑	↓	↑	↓
東部	↑	↑	↓	↑		↑	↓	↑	↓
					世紀末				
北部	↑	↓	↓	↑		↑	↑	↓	↓
中部	↑	↓	↓	↑		↓	↓	↓	↓
南部	↑	↓	↓	↑		↓	↓	↓	↓
東部	↑	↓	↓	↑		↓	↓	↓	↓

為ECHAM5-WRF與MRI-WRF在近未來及世紀末日溫差變化分佈表

Wet Day Change (Daily Precipitation > 1mm) , WRF

Near future - present

Spring Summer Autumn Winter Meiyu



Wet Day Change (Daily Precipitation > 1mm) , WRF
End of century - present