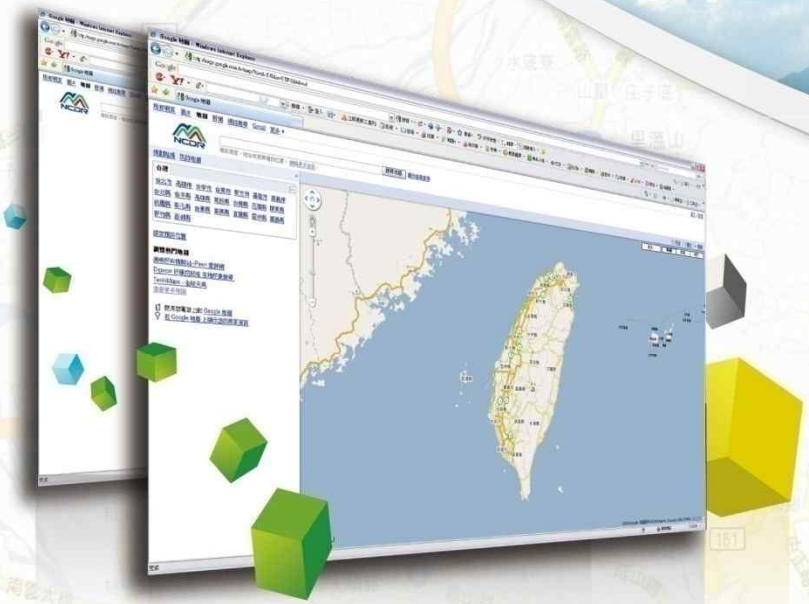
APEC Climate Symposium 2013
11 Nov - 13 Nov 2013
Jakarta, Indonesia

Case Study of 2011/2012 Spring Rainfall in Taiwan



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Outline

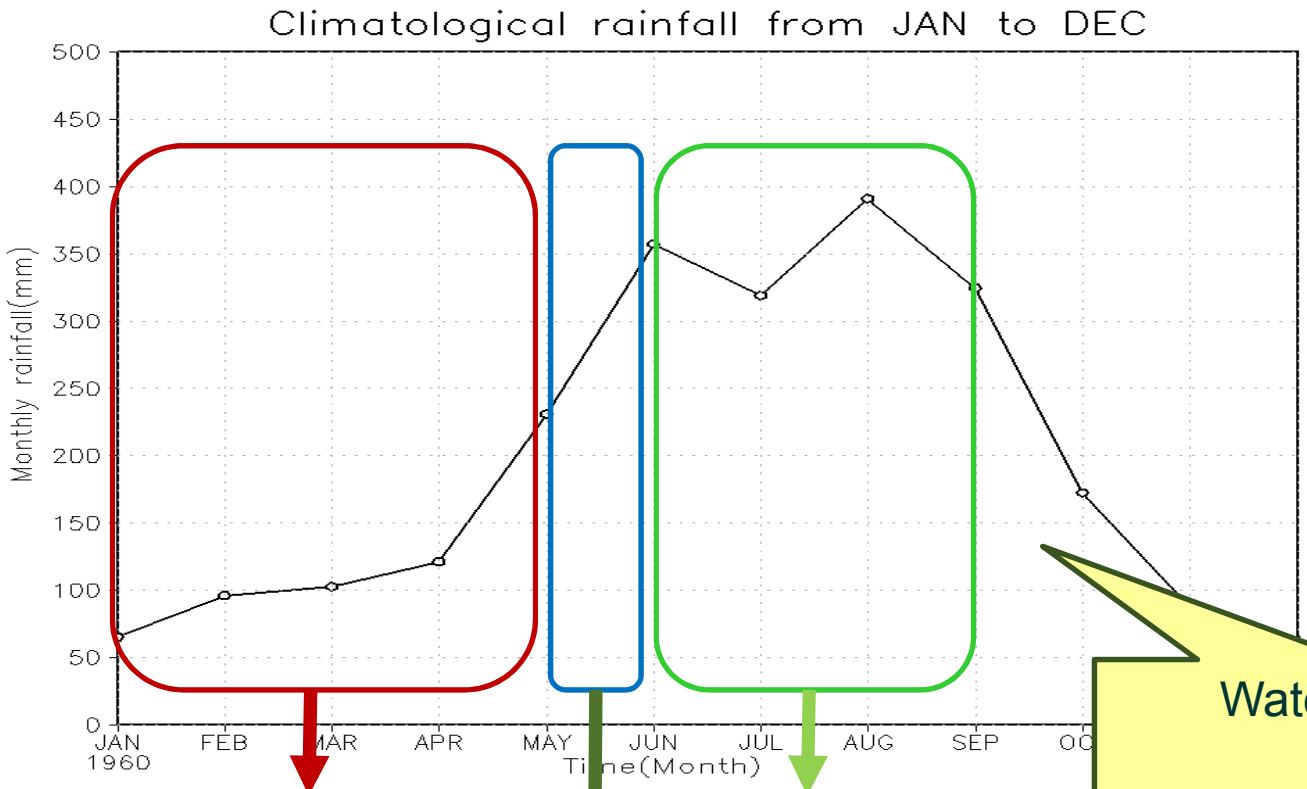
1. Brief introduction of spring rainfall in Taiwan
2. Relationship between spring rainfall and ENSO
3. Case study of spring rainfall in 2011/2012 (activity of front system)
4. Conclusion and discussion

Snapshot of Shihmen reservoir

Normal

Drought

http://b10851787.pixnet.net/blog/post/28227939



Spring Rainfall

Mei-Yu Rainfall

Typhoon Rainfall

Water Resources

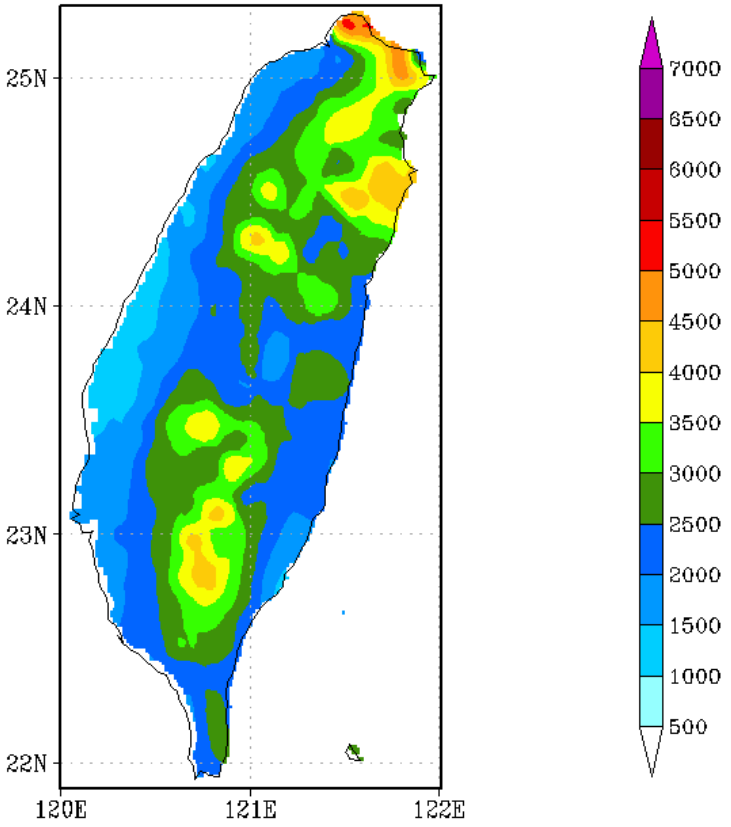
1. Drought happens frequently (about every 2 years) during dry season in Taiwan
2. How to allocate limited water is a big problem for Water resource management in Taiwan.

Contribution of water resources in Taiwan

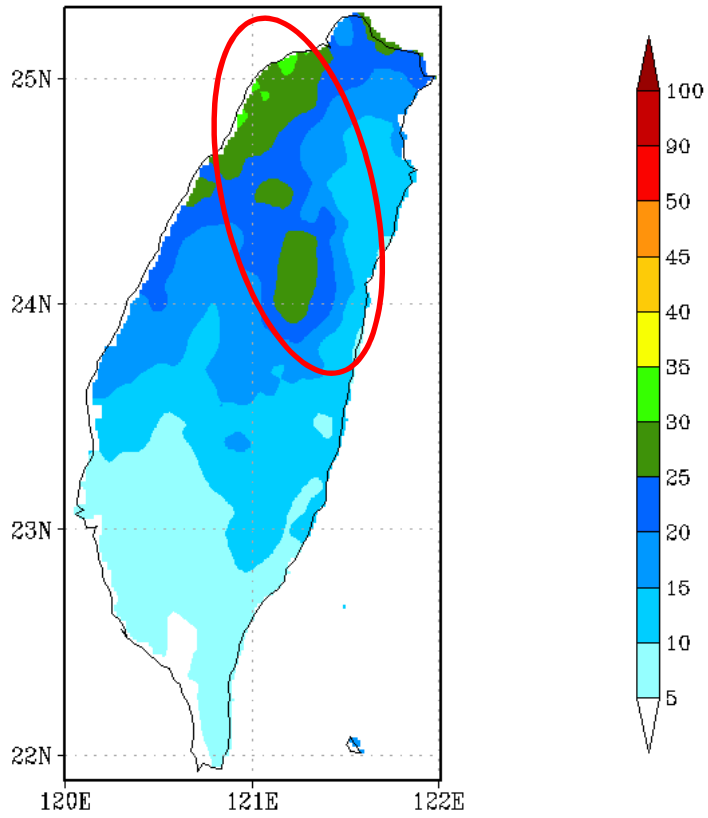
How important of Spring rainfall in Taiwan ?

Brief introduction of spring rainfall in Taiwan

Annual rainfall [mm/yr]



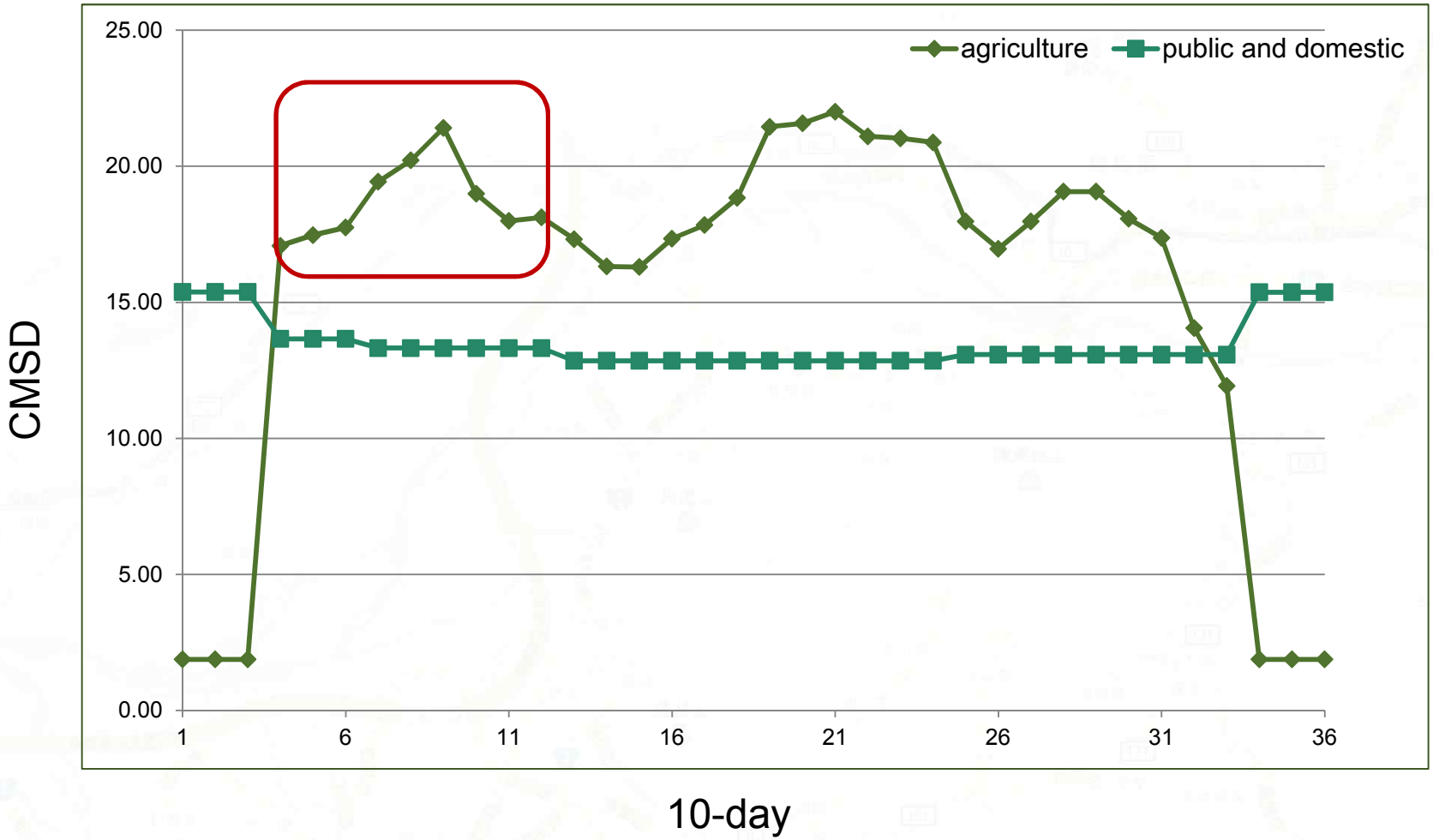
Percentage of Spring rainfall [%]



Spring rainfall contributes about 25% in northern Taiwan

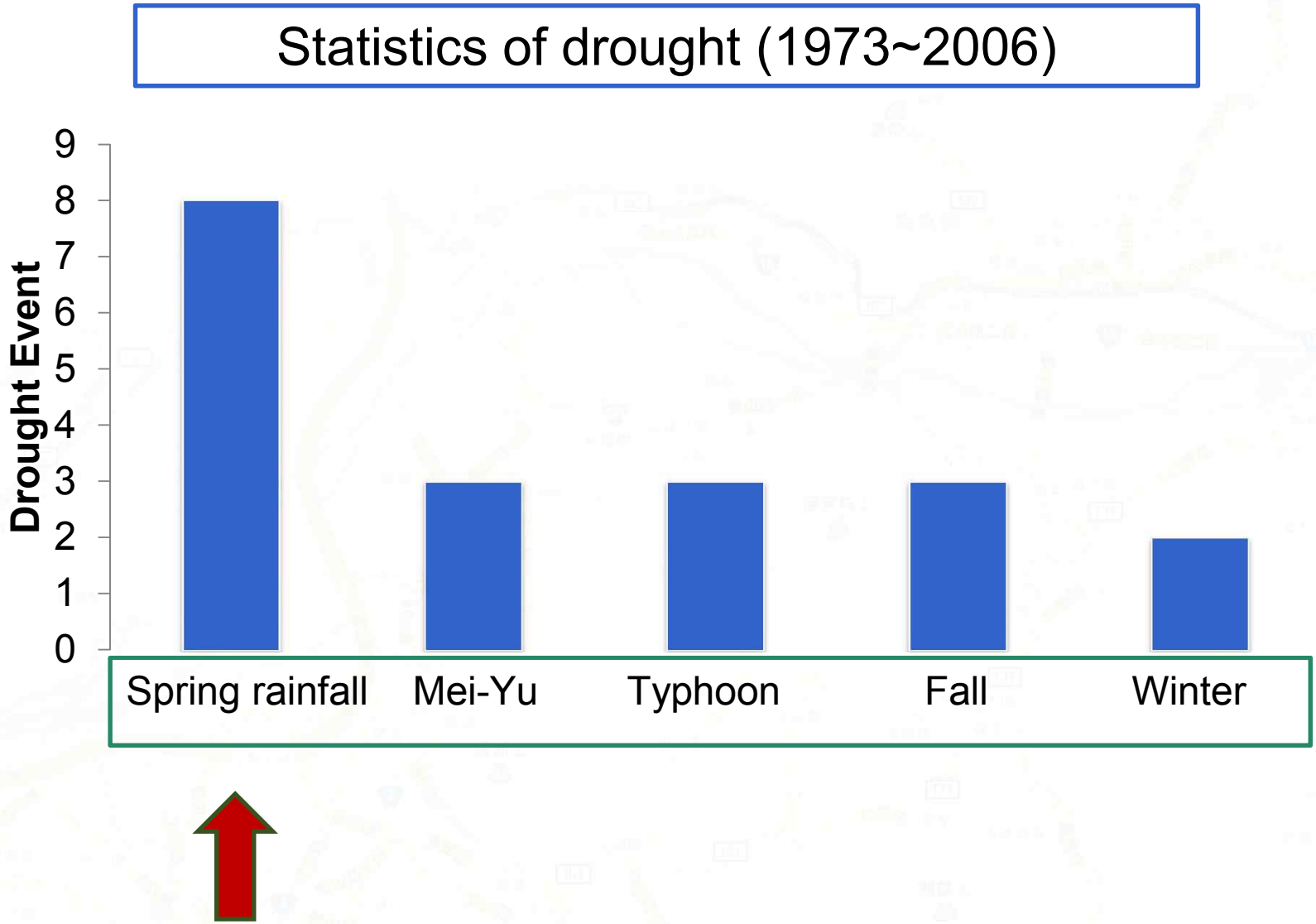
Brief introduction of spring rainfall in Taiwan

Water need of Shihmen Reservoir

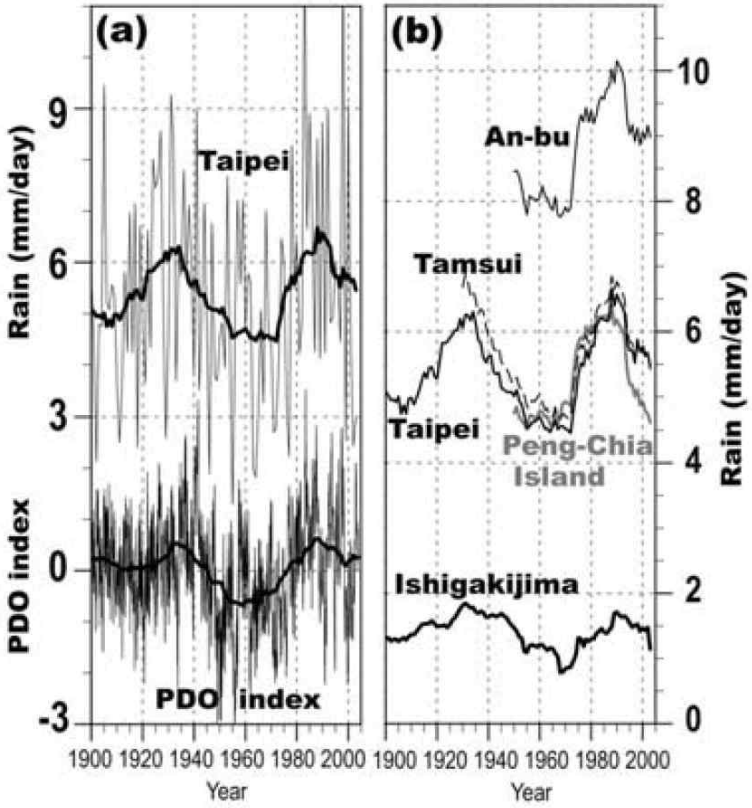


Spring rainfall is crucial for water resource management on Agriculture

Brief introduction of spring rainfall in Taiwan

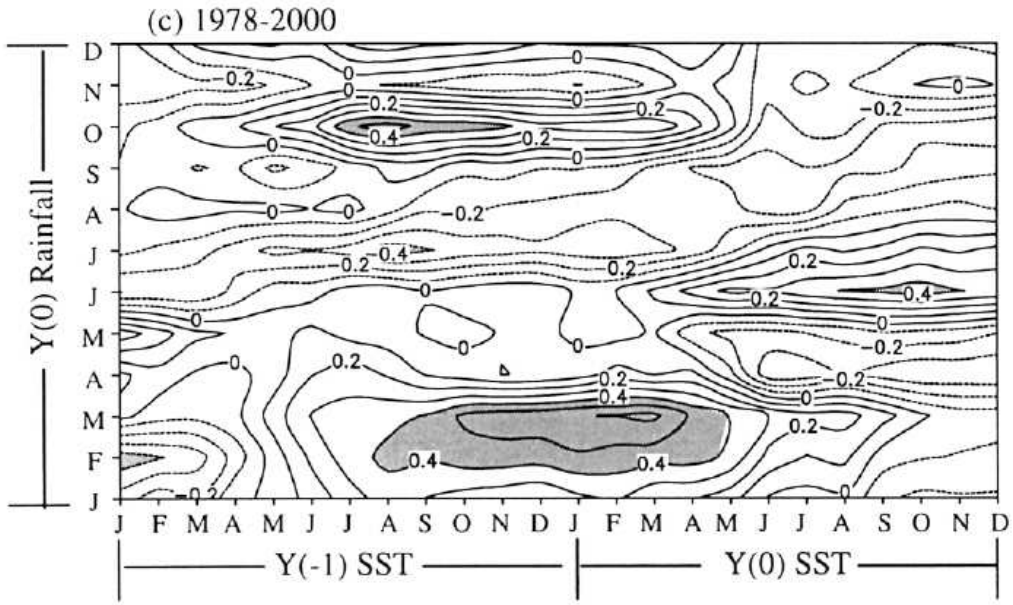


Is there any connection with climate phenomenon?



more (less) spring rain occurs in northern Taiwan during the positive (negative) PDO phases.

Hung et al., 2004

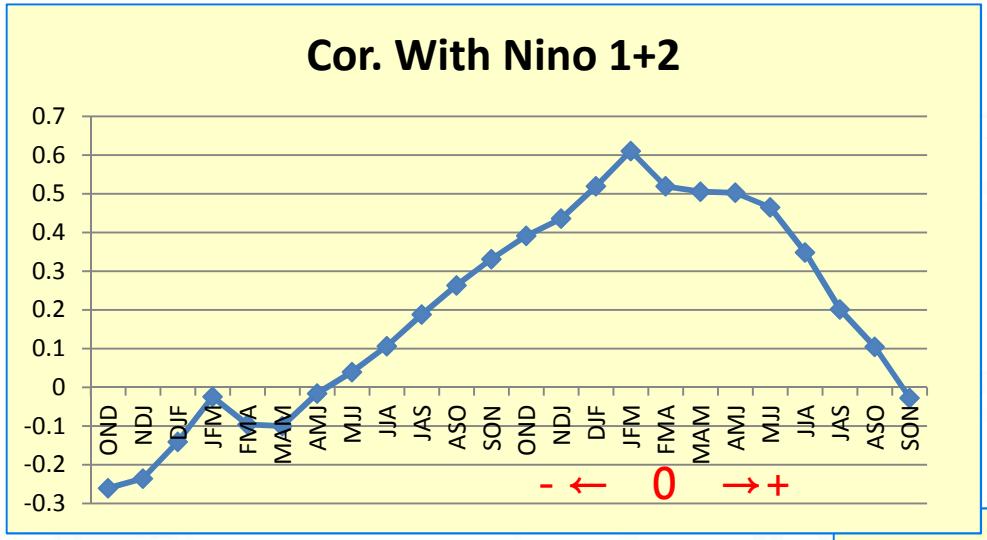


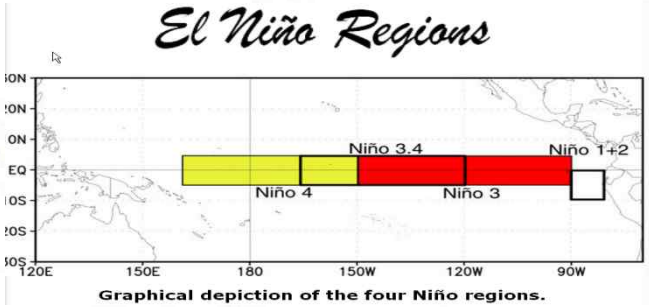
maximum correlation between the rainfall in February–March and Nino-3 SST occurs during the mature phase of ENSO from November to March.

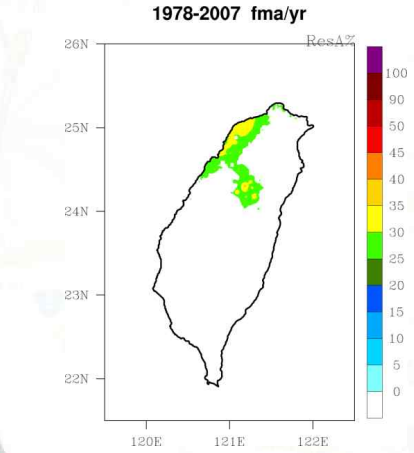
Jiang et al., 2003

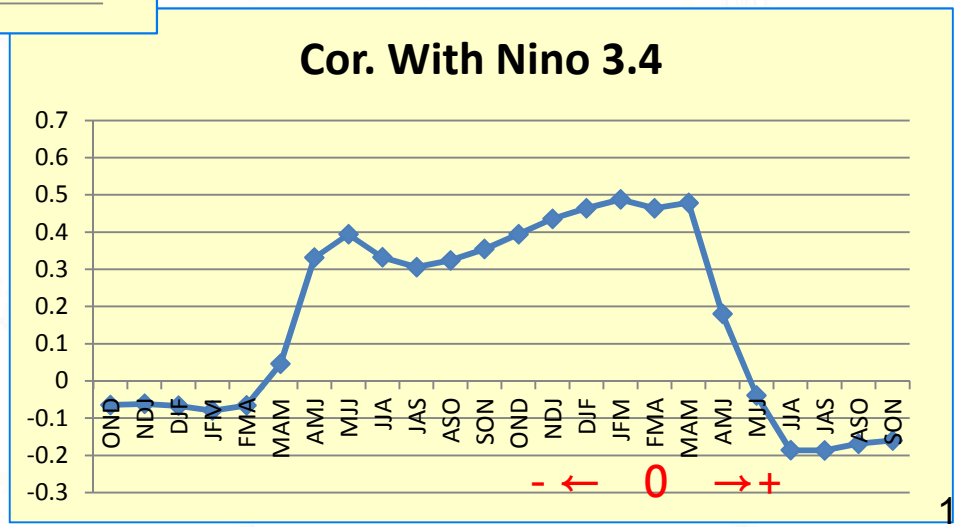
Relationship between spring rainfall and ENSO

Lag cor. Between Spring rainfall(1978-2009) and ENSO Index(1976-2009)





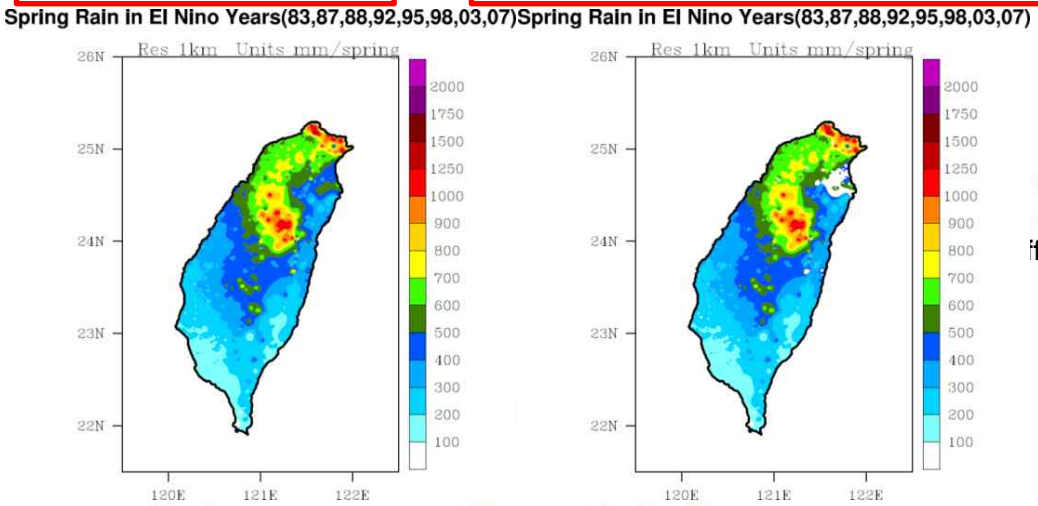




Relationship between spring rainfall and ENSO

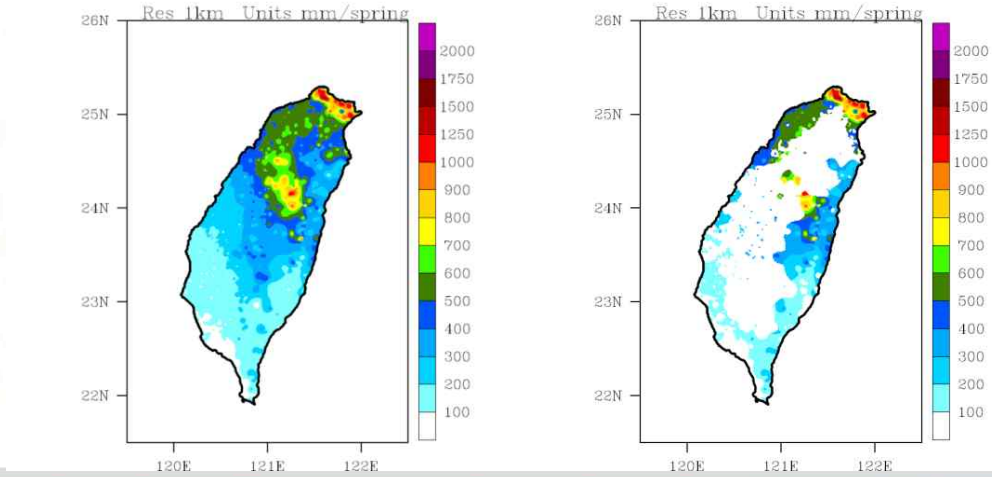
El nino years

El nino years (tested)



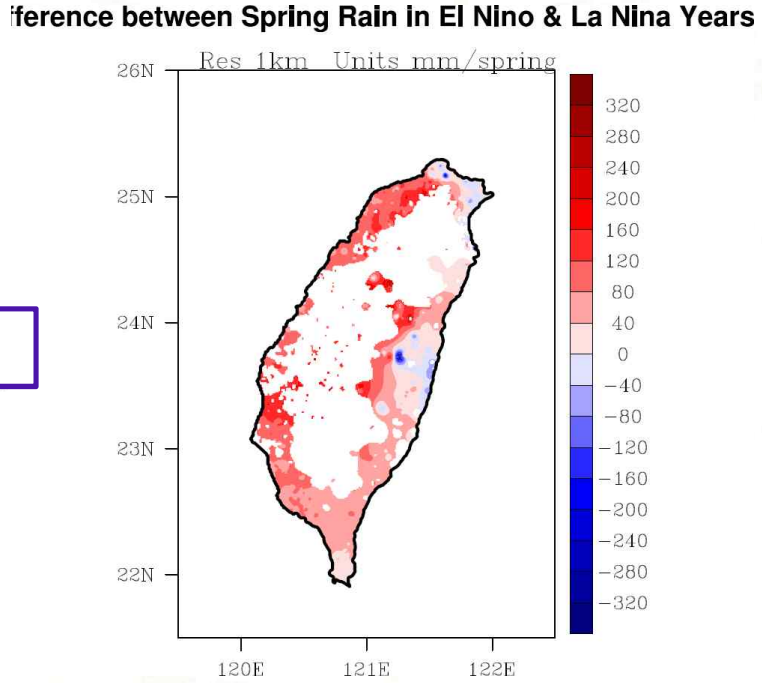
La Nina years

La Nina years (tested)

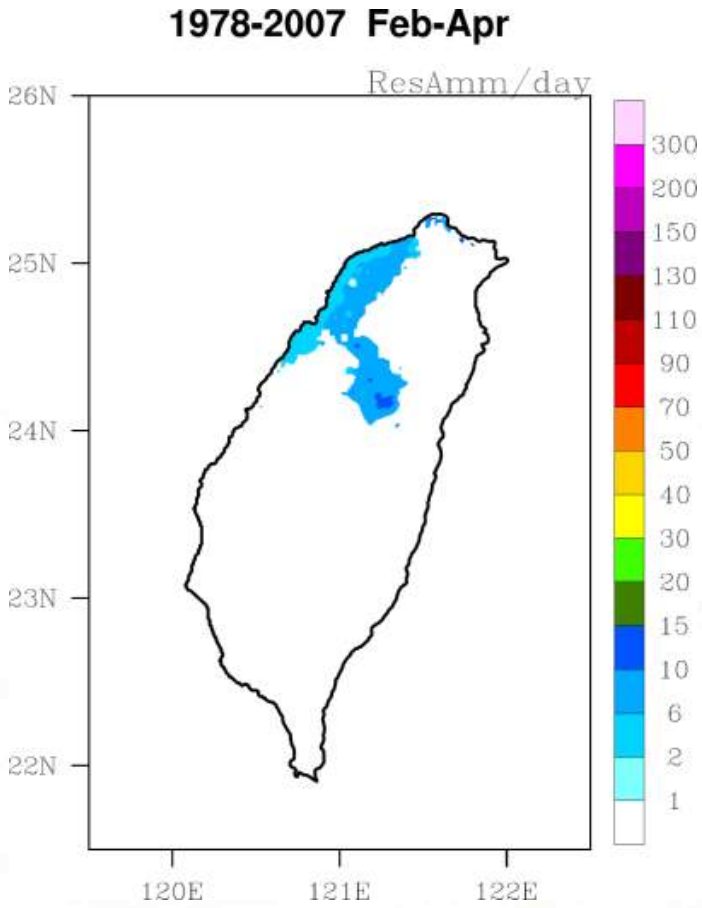


Nino Years
82/83, 86/87, 87/88, 91/92, 84/95, 97/98, 02/03, 06/07

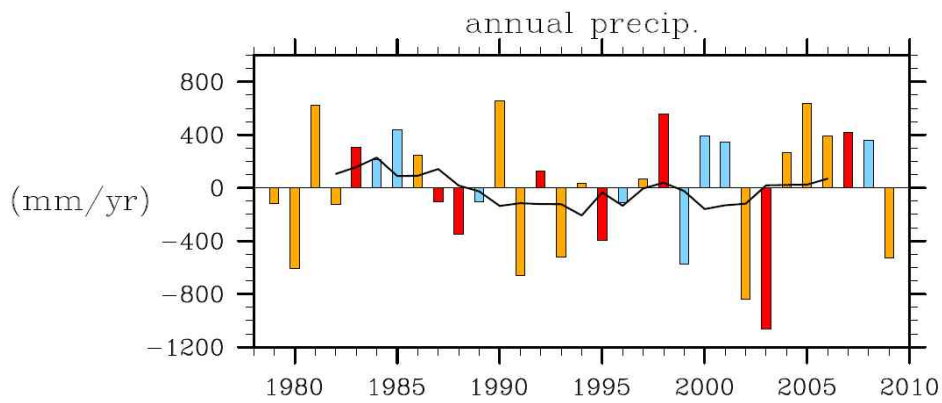
Nina Years :
83/84, 84/85, 88/89, 95/96, 98/99, 99/00, 00/01, 07/08



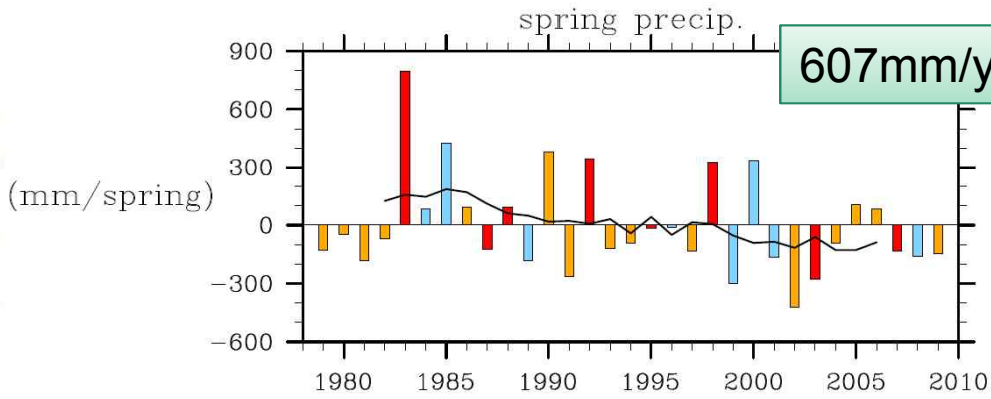
Inter-annual variability



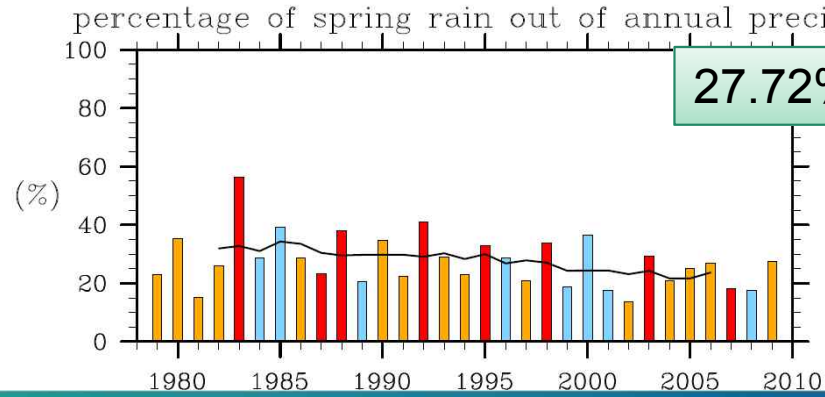
Orange: Non-ENSO years
Red: El Nino years
Blue: La Nina years
Black : 7-yr running mean



2189.7mm/yr



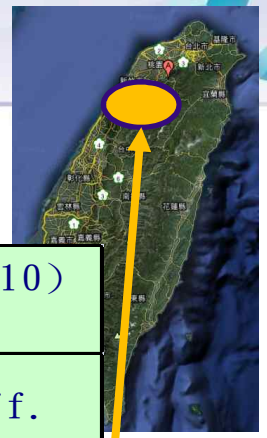
607mm/yr



27.72%

Case study of spring rainfall in 2011/2012

Water condition of reservoirs in Taiwan During 2011(April)



Area	Reservior Name	Present(4/19) storage		Present and History(2006~2010) Water storage comparison		
		Water storage	Rate of	Mean Of water	[present/mean]	Diff.
North	新山	826	80%	673	123%	152
	翡翠	24,278	72%	18,595	131%	5,683
	石門	7,435	35%	11,554	64%	-4,119
	寶山第二	1,107	35%	1,497	74%	-391
Middle	永和山	1,232	44%	1,612	76%	-380
	明德	504	40%	957	53%	-453
	鯉魚潭	4,658	40%	7,509	62%	-2,852
	德基	9,975	64%	10,889	92%	-914
South	蘭潭- 仁義潭	1,133	33%	945	120%	188
	曾文- 烏山頭	13,924	24%	18,076	77%	-4,152
	南化	3,285	34%	3,057	107%	227
	牡丹	1,501	54%	1,173	128%	328

Unit: million M^3

Emergency Operation meeting for drought

2011.03.30

Water restriction stage I
90% of normal water supply for Agriculture

2011.04.21

Water level in reservoirs keep decreasing

2011.05.09

Drought extend gradually from north to south of Taiwan

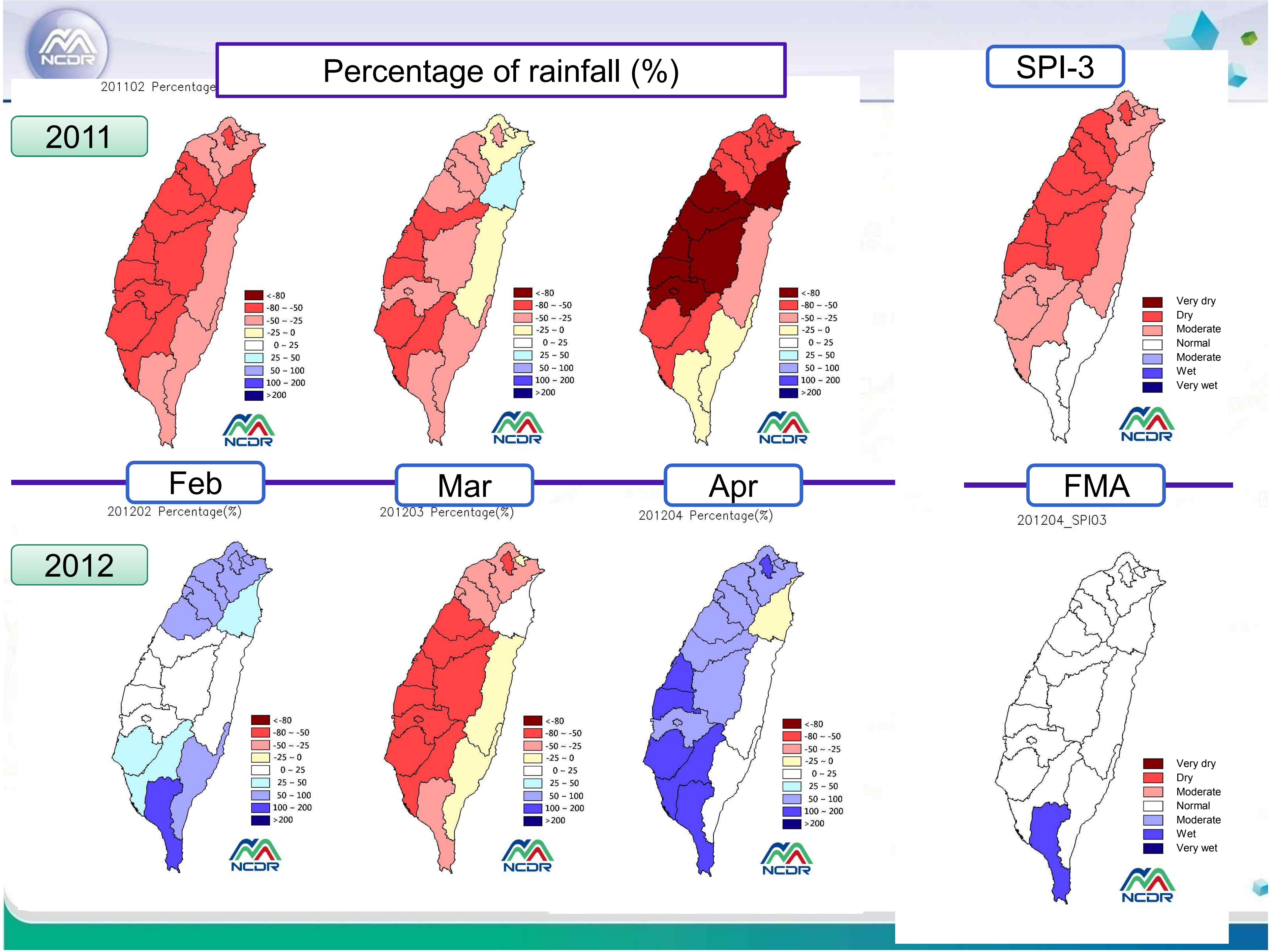
2011.05.16

4th EOC meeting

2011.06.29

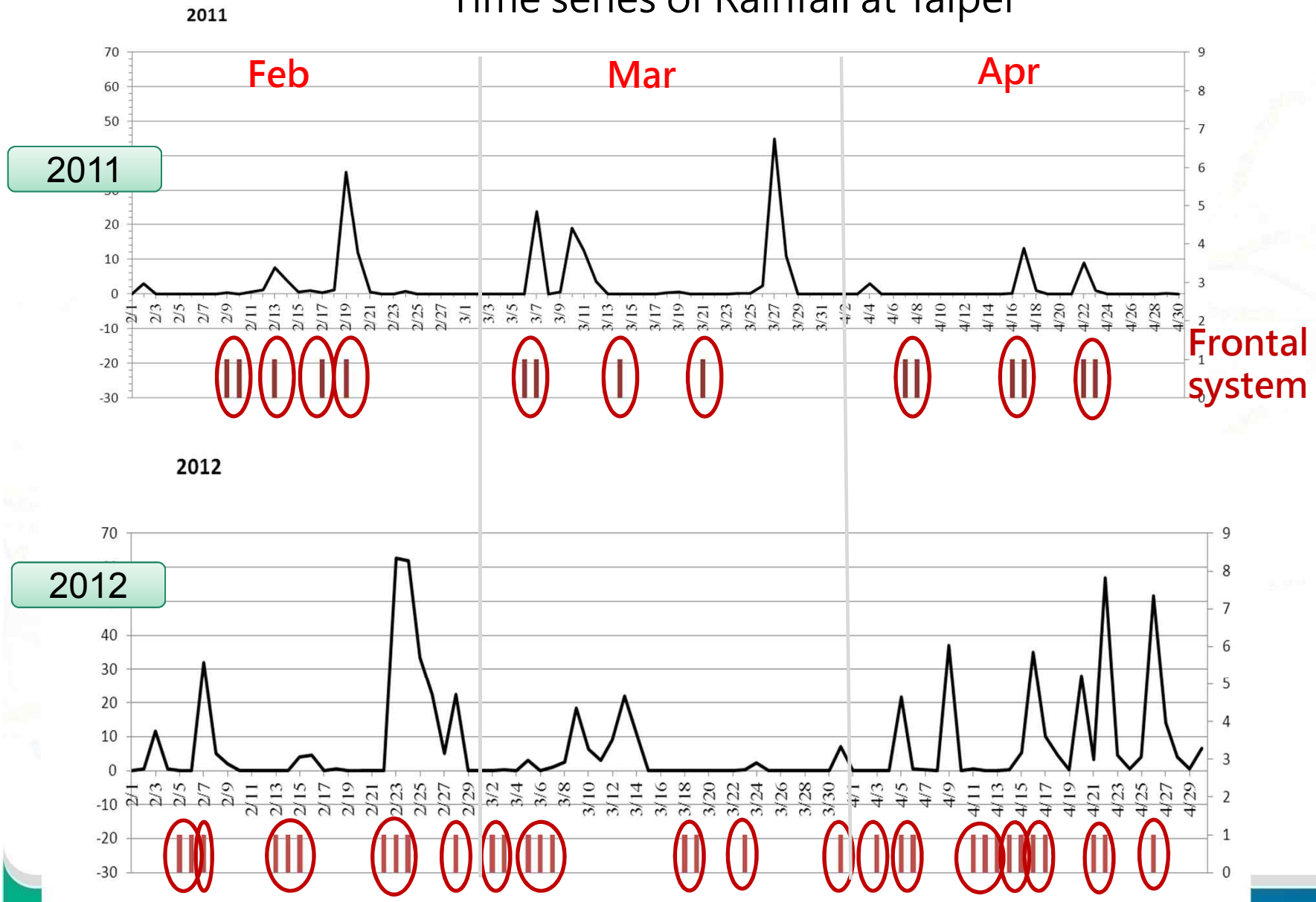
CEOC closed due to rainfall brought by 3 mei-yu fronts

Water restriction is initiated


Percentage of rainfall (%)
SPI-3
2011
201102 Percentage
<-80
-80 ~ -50
-50 ~ -25
-25 ~ 0
0 ~ 25
25 ~ 50
50 ~ 100
100 ~ 200
>200
Very dry
Dry
Moderate
Normal
Moderate
Wet
Very wet
NCDR
Feb
Mar
Apr
FMA
201202 Percentage(%)
201203 Percentage(%)
201204 Percentage(%)
201204_SPI03
2012

Comparison of Front activity during Spring time

Time series of Rainfall at Taipei



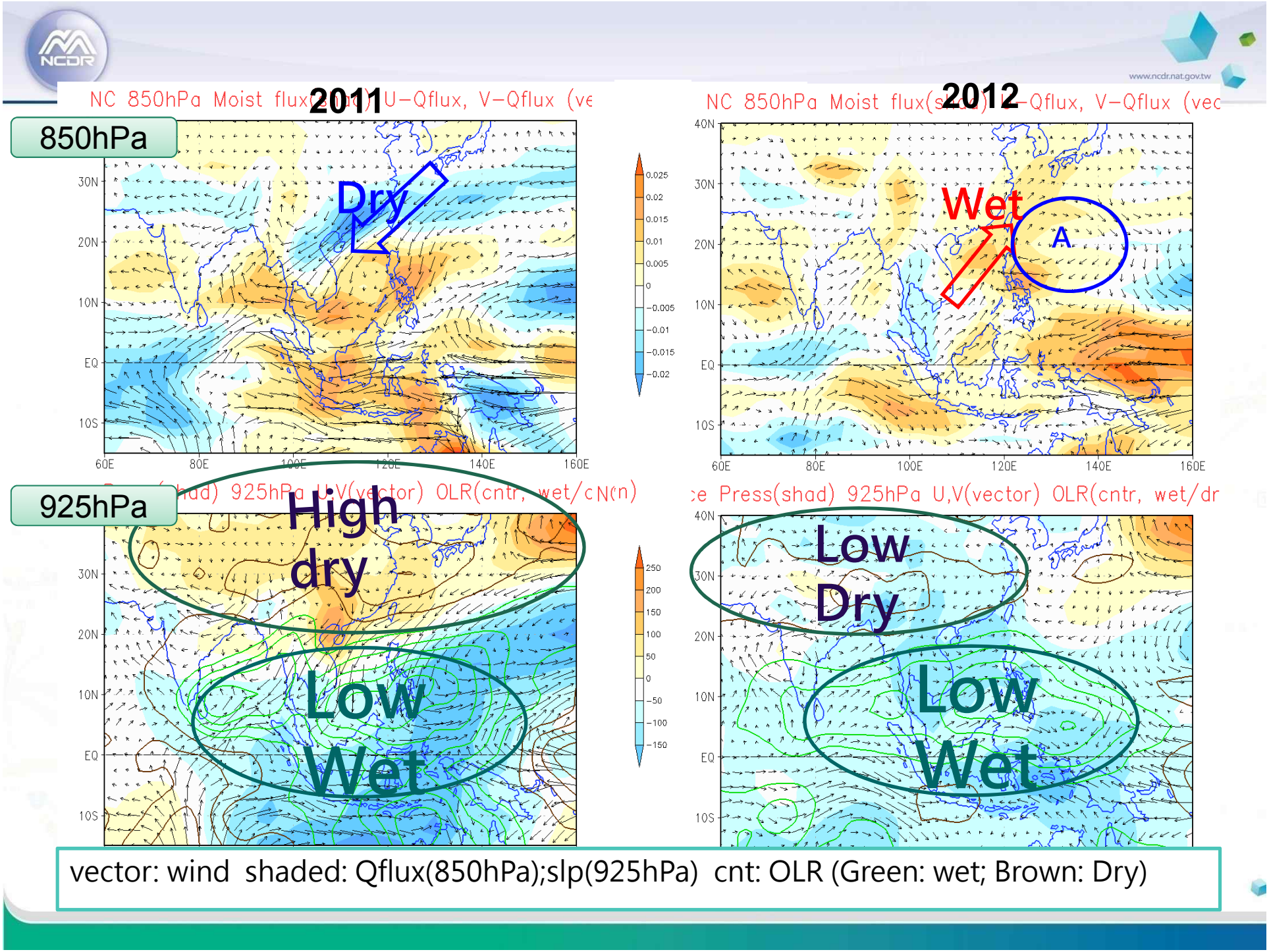
Frontal activity

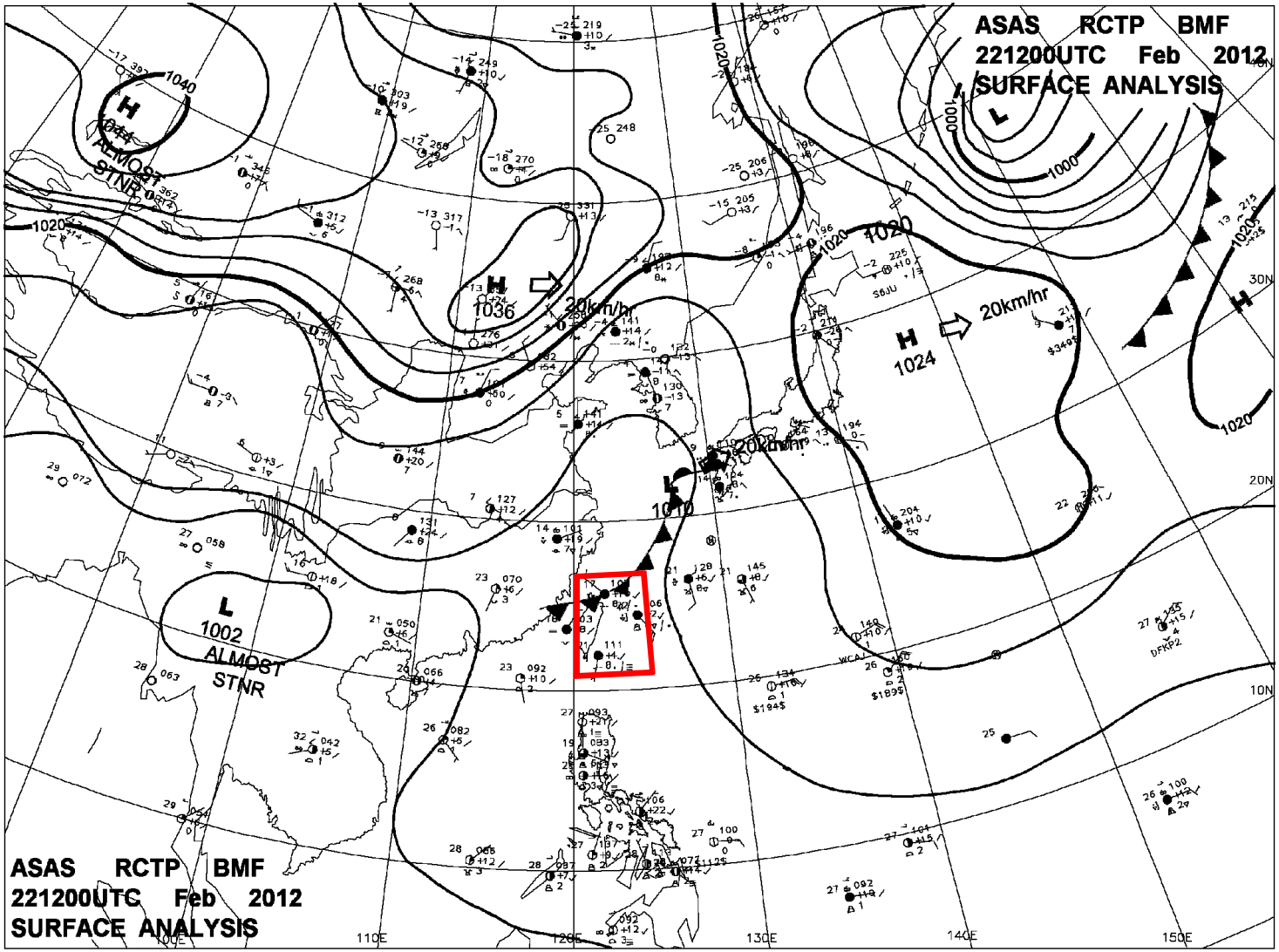
Taiwan	2011	2012	2012/2011
Affecting time (day)	15	32	2.13
Freq. of Front	10	17	1.70
averaged duration(Day/Freq)	1.5	1.9	1.25

East Asia	2011	2012	2012/2011
Freq. of Front over E.A.	29	33	1.14
Freq. of Front over Taiwan	10	17	1.70
Ratio (TW/EA)	35%	52%	1.49

- Less frontal activity and short duration are found in Taiwan during 2011
- Frontal activity is similar in both of 2011 and 2012

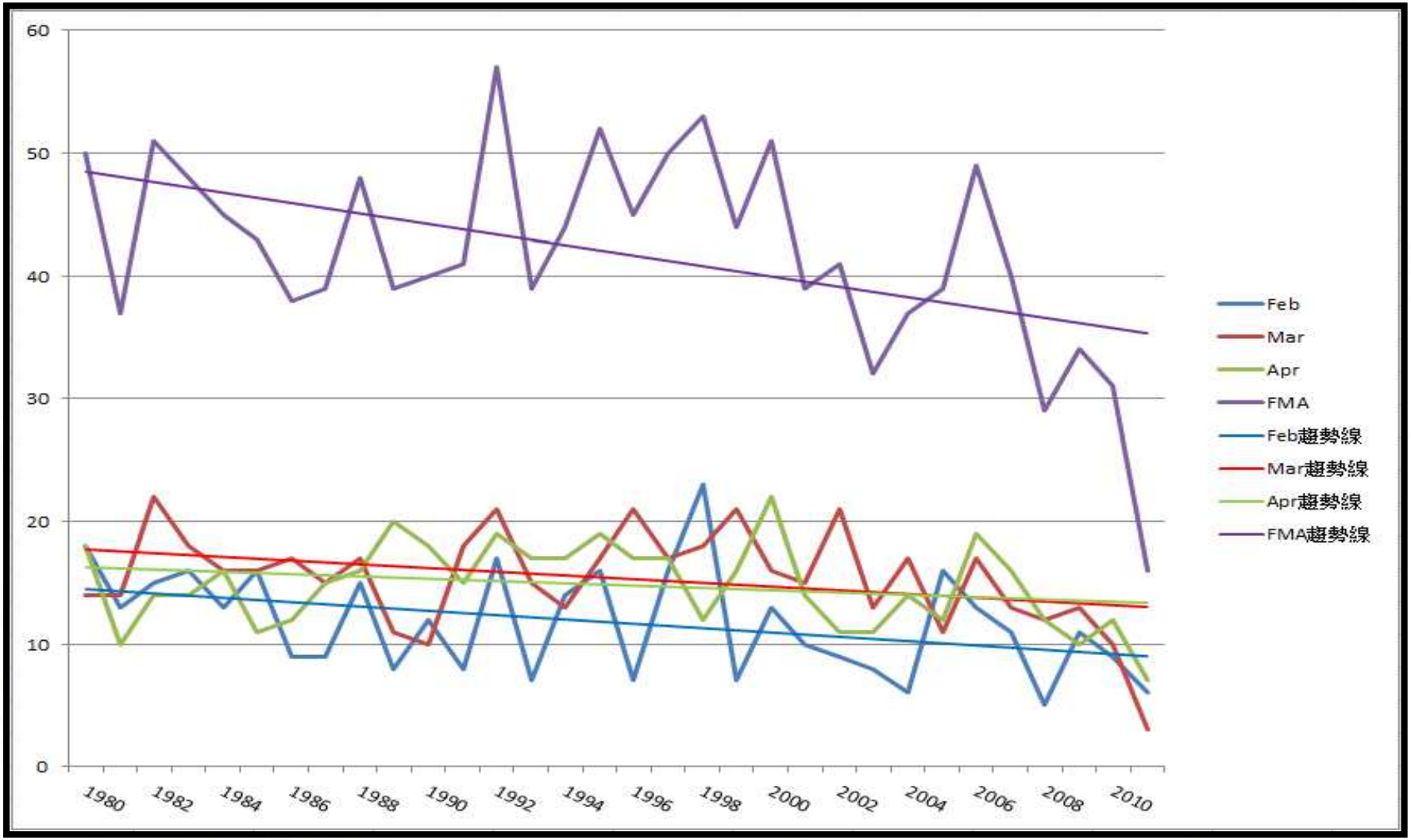
=> Spring rainfall is associated with the speed and path of frontal systems that pass through Taiwan


2011
2012
850hPa
Dry
Wet
A
925hPa
High
dry
Low
Wet
Low
Dry
Low
Wet
vector: wind shaded: Qflux(850hPa);slp(925hPa) cnt: OLR (Green: wet; Brown: Dry)


ASAS RCTP BMF
221200UTC Feb 2012
SURFACE ANALYSIS
H
1036
20km/hr
H
1024
20km/hr
20km/hr
L
1010
L
1002
ALMOST
STNR
H
1044
ALMOST
STNR
1040
1020
1000
30N
20N
10N
100E
110E
120E
130E
140E
150E

Case study of spring rainfall in 2011/2012(cont.)

Day of frontal activity (1980~2011)



Conclusion and discussion

- The spring rainfall contributes almost 25% to annual rainfall in northern Taiwan. Higher cor. is found in between the spring rainfall of northern Taiwan and the SST of Nino3.4 of previous winter.
- Above normal precipitation are expected for warm episodes, but the variation is not consistent for cold episodes.

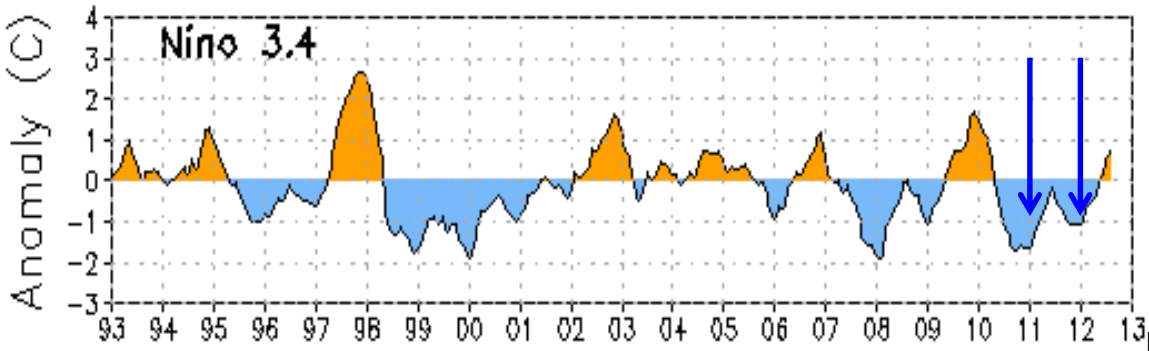


Figure from CPC

Conclusion and discussion

- Spring rainfall is associated with the speed and path of frontal systems that pass through Taiwan. The differences in front number and affecting time led to below normal spring rainfall in 2011 and above normal spring rainfall in 2012, while the total numbers of frontal system over East Asia of both years are similar.

- Both of rainfall and front number tend to decrease for Northern Taiwan in spring time.

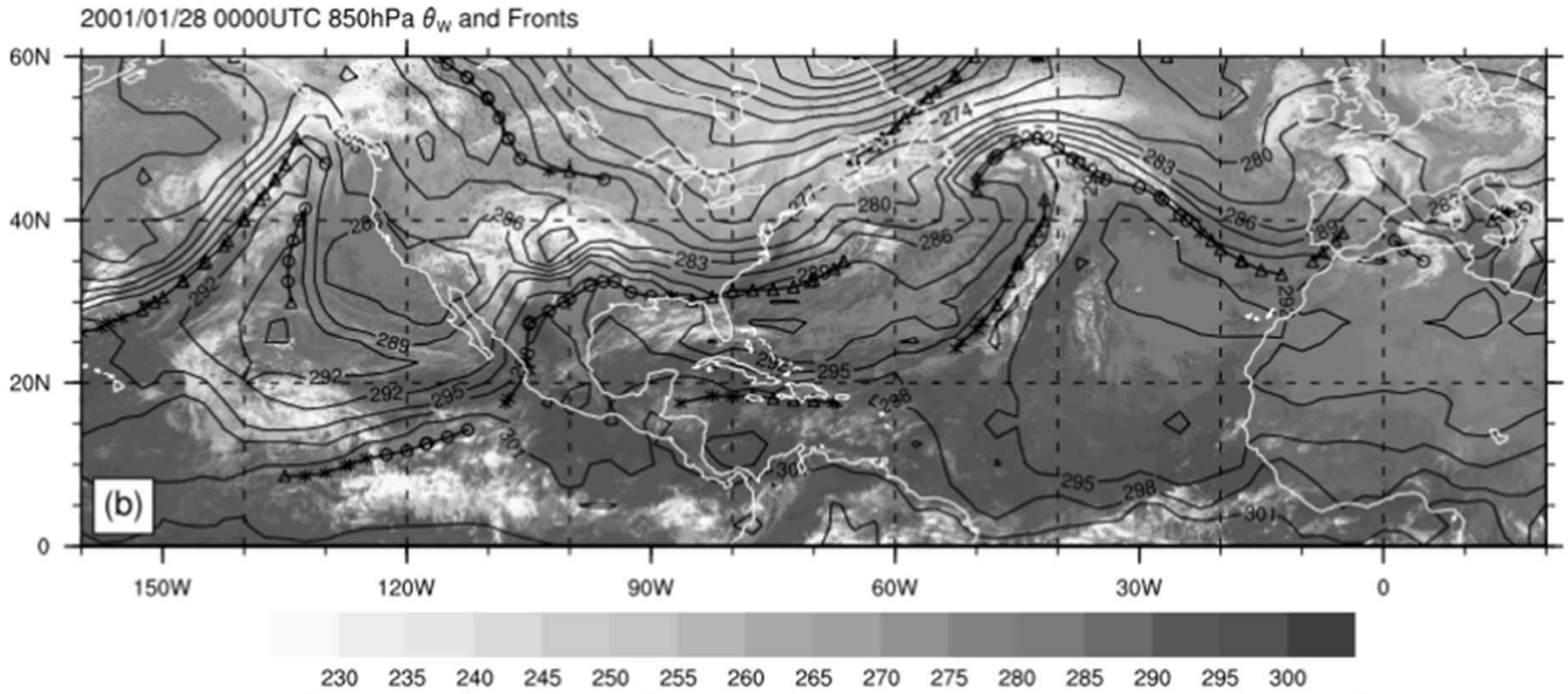
- Further investigation is required to understand the relationship between the frontal activity and large scale circulation over East Asia.

Conclusion and discussion

Ongoing work

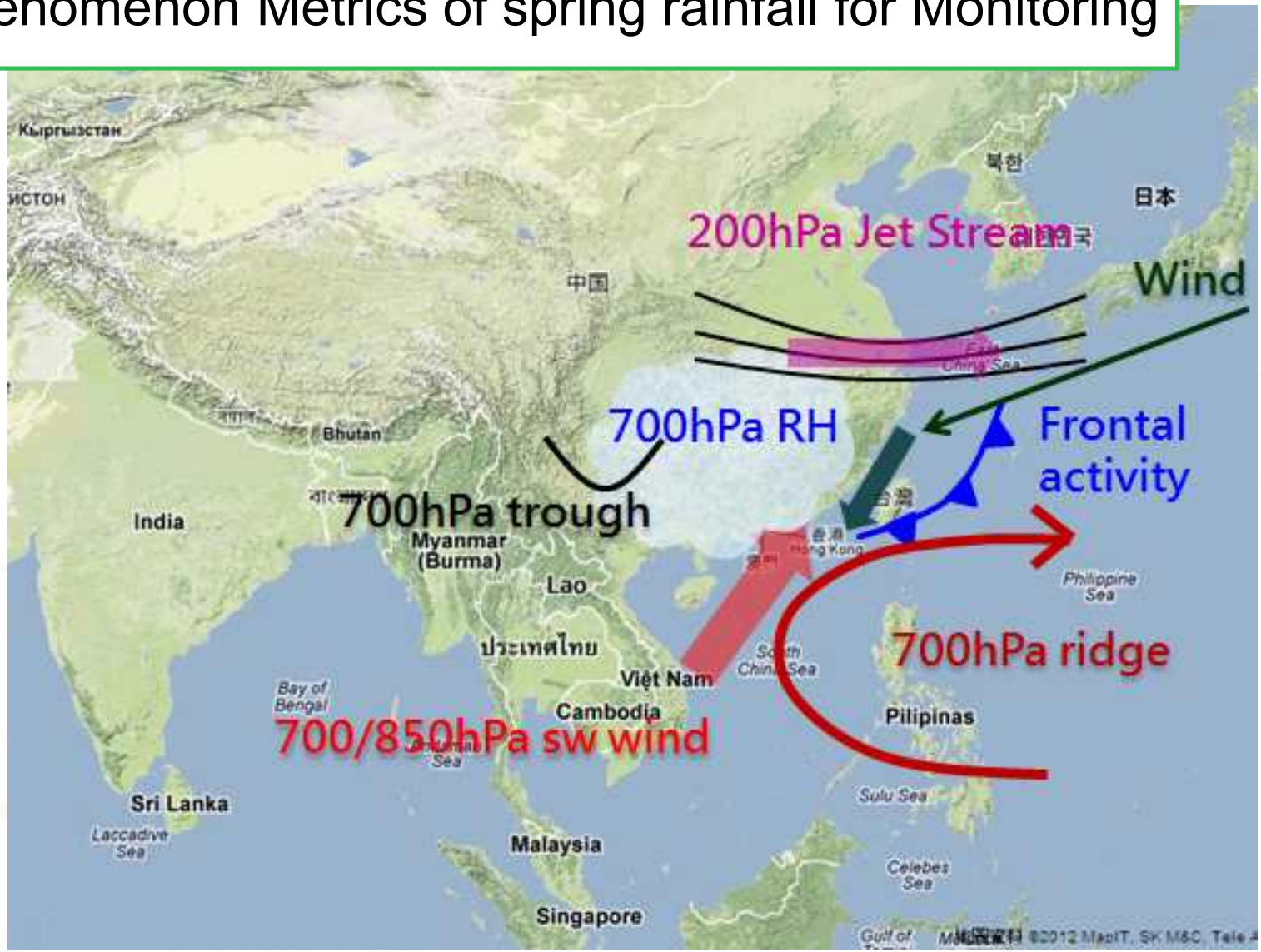
Objective detection for Frontal activity

Hewson (1998)

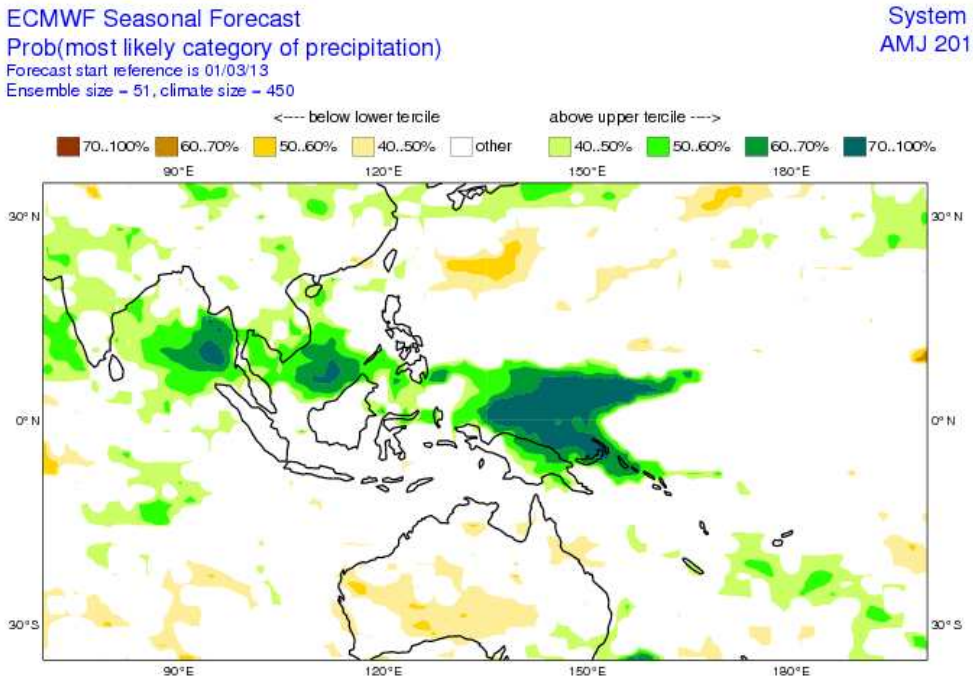


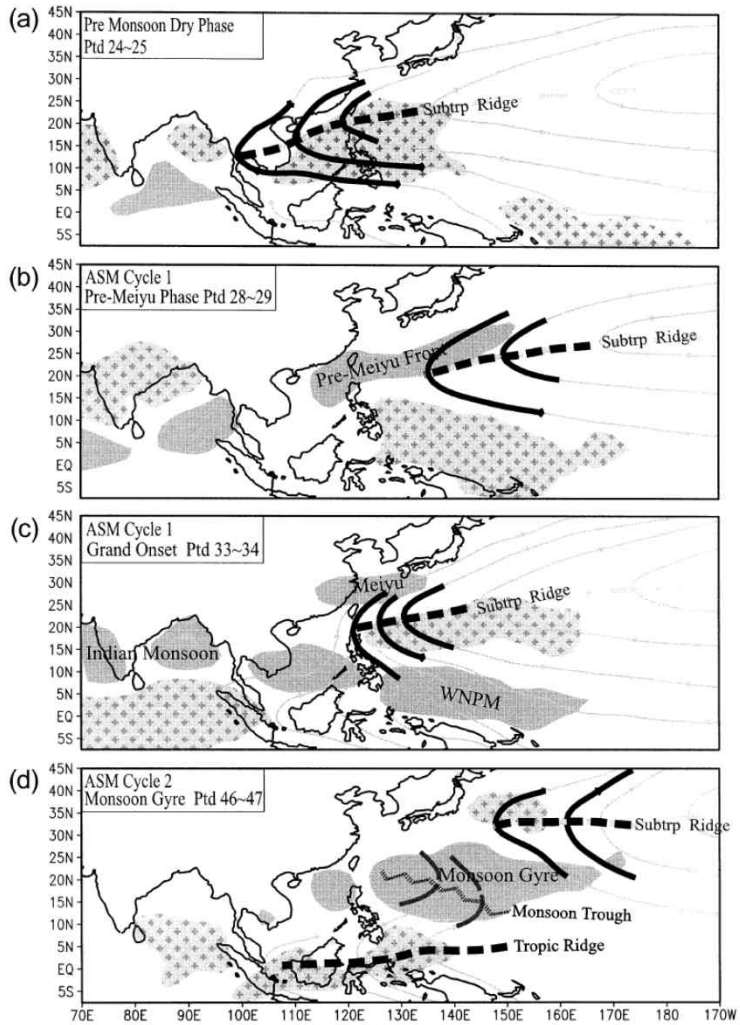
Berry et al (2011)

Phenomenon Metrics of spring rainfall for Monitoring



Climate Monitor (fast annual cycle)





(LinHo & Wang，2002)

To provide more information for the progress of climate condition behind rainfall/temperature seasonal forecast.

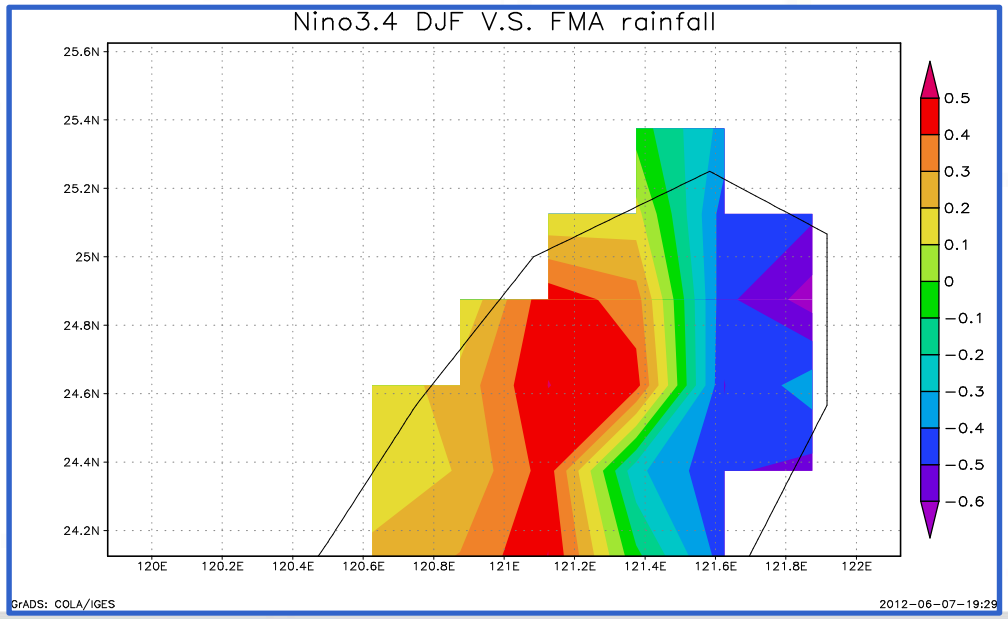
Statistical Downscaling based on Tropical SST in previous winter

Spring rainfall
(FMA 1)

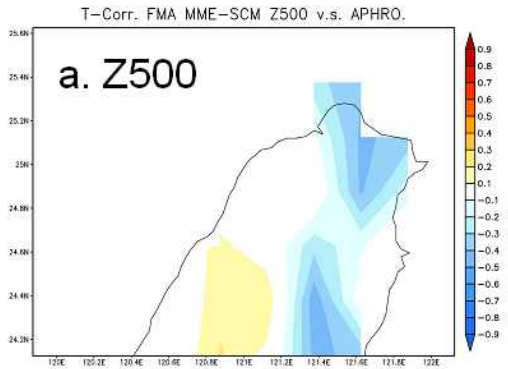
SVD

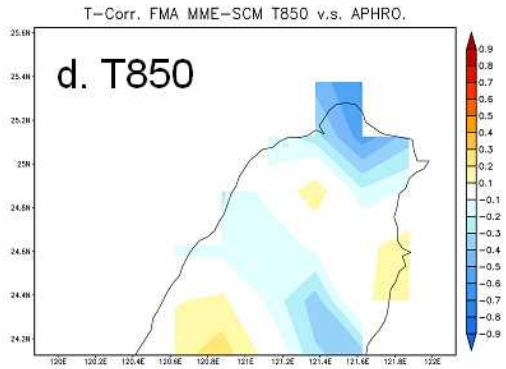
Nino3.4 SST
(DJF 0/1)

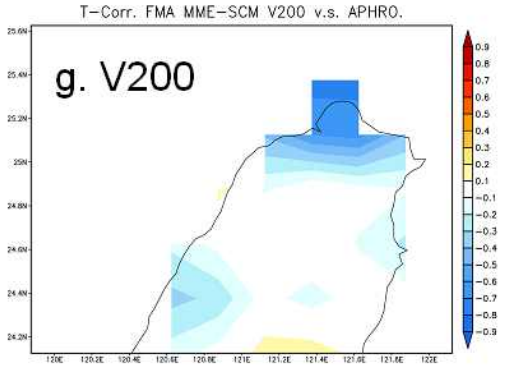
Statistical
Downscaling

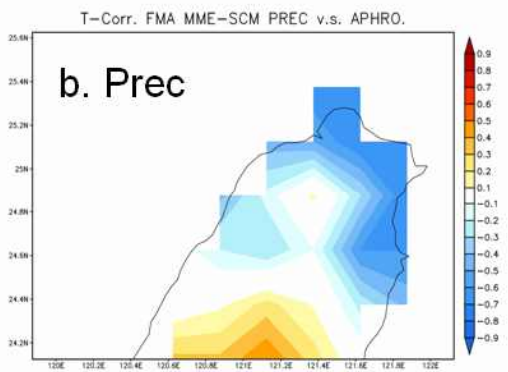


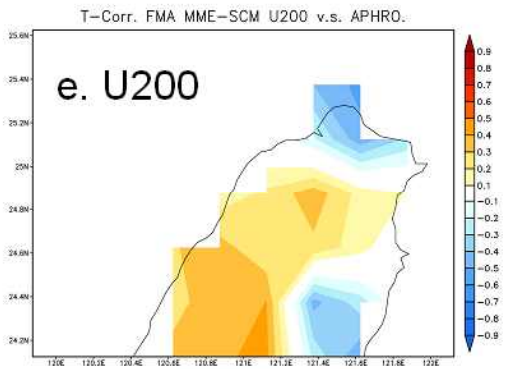
Statistical Downscaling based on Model outputs

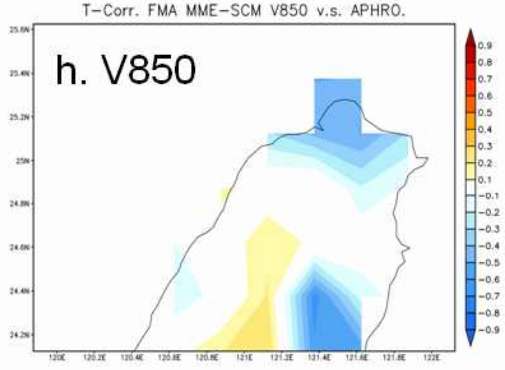


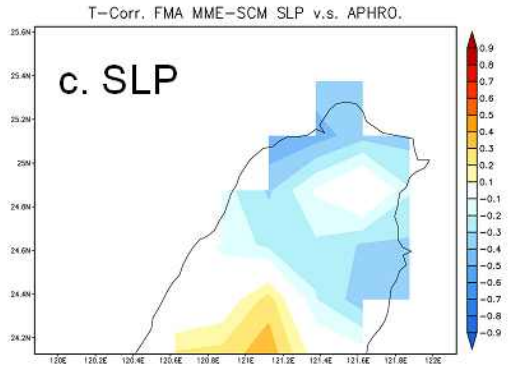


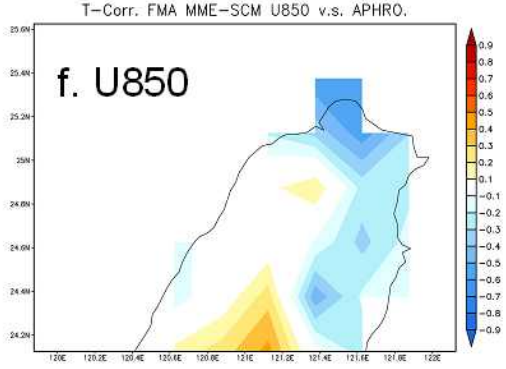






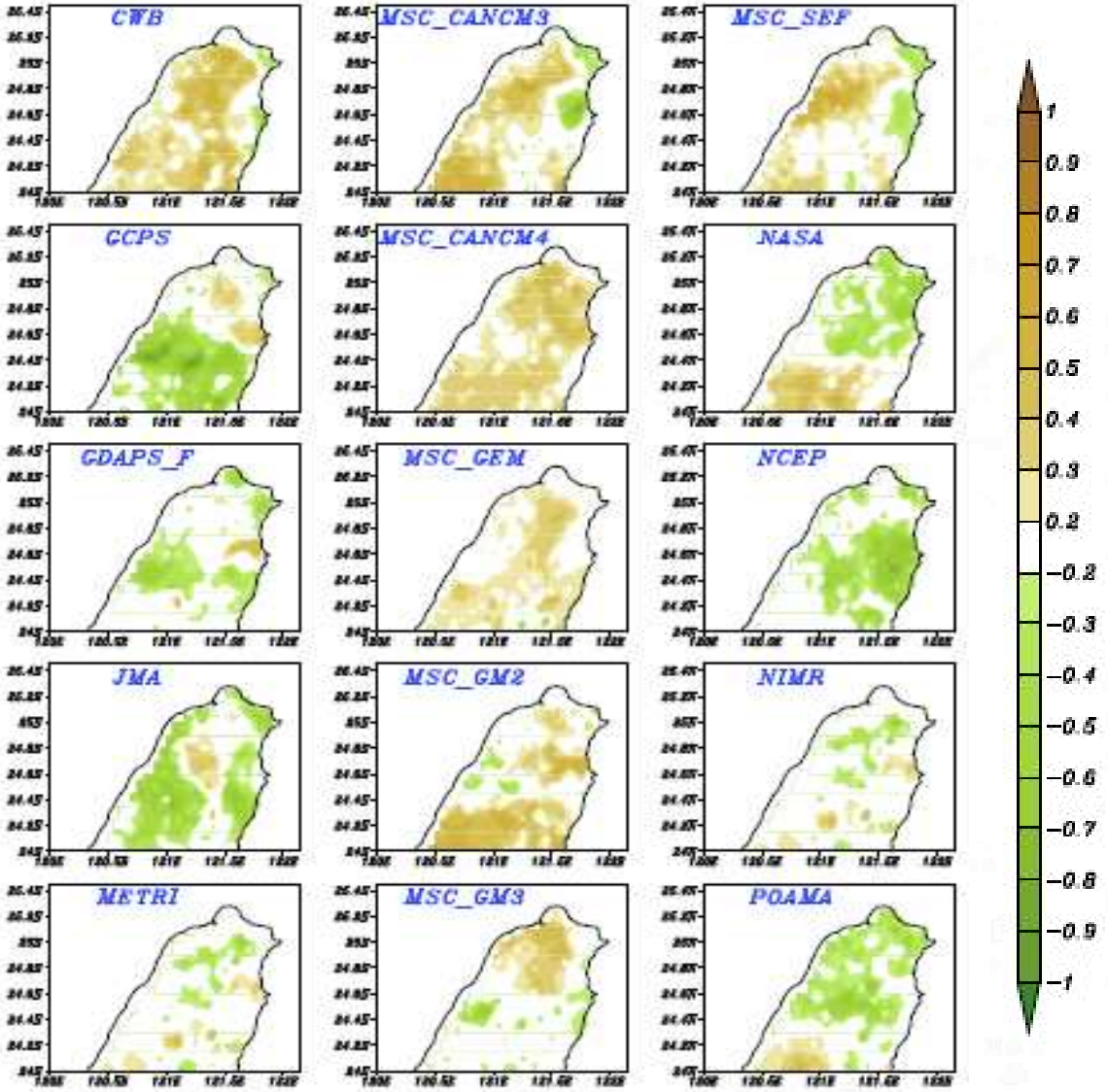






T-COR APCC 3-month MME (Hindcast, FMA)

Statistical Downscaling based on Model outputs



T-COR APCC 3-month (Hindcast, FMA,U200)

Thank you very much.