문서번호 APCC-출장-17-1416(2017-11-24)

결재	연구원	팀장	부서장	원장
	11/23 정다은	11/23 이우섭	11/24 유진호	11/24 정홍상
협조				

TRAVEL REPORT FORM
출장보고서

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측팀	연구원 선임연구원	정다은 이윤영	2017/11/13~ 2017/11/17	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동
   - 참가 회의 : Sixth Internaitonal Workshop on Monsoon (IWM-6)
   - 일시 : 2017년 11월 13일~2017년 11월 17일
   - 장소 : 싱가포르
   - 주요내용 및 활동 : monsoon paper review 세션 참석 및 short course에 참여하여 CLIK 소개·강의·실습

2. Relevance to APEC Climate Center's Activities 결론 및 소감
   - regional monsoon, S2S, high-impact weather, 모델링 및 기후변화까지 다양한 분야의 세션에 참석하여 최신 연구 동향을 파악할 수 있었음
   - 위와 같은 다양한 분야에 대한 논문 리뷰가 있었으며 연구자들의 최신 연구 또한 소개되었음
   - short couse에 참여하여 여러 기상청 기후예측 실무진들에게 센터의 다운스케일 도구 중 하나인 CLIK 실습 강의 및 MME 강의를 수행하였음
   - 본 워크숍 참석을 통해 각국 기상청의 CLIK 활용이 도모될 것으로 기대됨

III. **References** 참고사항

(with attachment of any information or report in case of attendance of conferences, workshops and meetings) 학술대회, 워크숍, 회의 등 참석 시 관련 정보 및 문서 첨부

1. Presented and Collected Materials 주요 수집자료
   - 초록집 하드카피 2부
2. Suggestions and Remarks 건의사항

문서번호 APCC-출장-17-1402(2017-11-22)

결재	선임연구원	팀장	부서장	원장
	11/21 김해정	11/21 김선태	11/22 유진호	11/22 정홍상
협조				

TRAVEL REPORT FORM
출장보고서

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측본부 기후연구팀	선임연구원 연구원	김해정 정유림	2017.11.12.-19.	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- The Sixth WMO International Workshop on Monsoons 참석
  - Regional Monsoon, High-Impact Weather, S2S, Modeling, Climate Change에 관한 최신 연구 동향 파악

- Intaseasonal & S2S session에서 발표
  - APCC BSISO 정보 서비스의 활용 방법 발표 [김해정, 붙임1]
  - 동아시아 여름철 몬순에 대한 BSISO 영향 평가 발표 [정유림, 붙임2]

- Short Course에서 강의
  - Tropical Forecasts 를 다룬 Short Course에서 BSISO 정보 해석 방법을 강의함으로써 Mr. Tierry Lefort(Meteo-France)와 협업

- APCC S2S Training Program 관련 논의
  - 추후 APCC TP 시 Dr.Yuhei Takaya(MRI)의 강의 참여 의사 확인

- CWB 로부터의 방문 요청 (2018년 3월경) 검토 중
  - APCC BSISO 이해와 활용에 대한 강의 예정
  - APCC BSISO 예측 model provider 로서의 CWB forecast skill 평가 예정
  - APCC BSISO 예보로의 CWB의 새로운 예측 모델 자료 도입 논의 예정

2. Relevance to APEC Climate Center's Activities 결론 및 소감

- APCC BSISO 정보의 유용성 확인
  - APCC의 BSISO 정보를 각 국 현업 예보에서 활용하고 있는 사례가 많아졌고 (MSS in Singapore, CWB, Meteo-France 등) 특히 호우 확률 예보가 유용하다고 함. 센터가 허락하는 선에서 추후 좀 더 다양한 방식으로 NMHs 실무진들을 지원할 수 있는 방안을 모색해보았

으면 함.

- 예보관들을 중심으로 실제로 여름철에는 MJO 보다 BSISO 정보가 더 유용하다는 피드백 수집. 이는 우리가 모니터링한 결과와 일치함.
- BSISO 존재 자체도 널리 알려지지 않았던 4년전의 IWM에 비하면 상당히 고무적인 상황임.

- 아프리카 몬순, 남미 몬순 등 아시아 몬순 이외의 지역 몬순에 대한 연구들이 예년에 비해 많이 진행되고 있고 high impact weather 에 대한 관심이 고조됨을 느낄 수 있었음.
- Review 발표들을 통해 인도, 동남아시아, 동아시아 몬순에 대한 이해도를 높일 수 있었고 습득된 연구 결과들은 차년도 BSISO 현업 시 참고 자료로 활용될 계획임.

III. References 참고사항

(with attachment of any information or report in case of attendance of conferences, workshops and meetings) 학술대회, 워크숍, 회의 등 참석 시 관련 정보 및 문서 첨부

1. Presented and Collected Materials 주요 수집자료

2. Suggestions and Remarks 건의사항

November 15, 2017

Enhancing the practical usefulness of APCC's BSISO information
: Development of a user guide for heavy rainfall probability forecast on subseasonal timescale

Hae-Jeong Kim* and Yoo-Rim Jung

APEC Climate Center, Busan, Republic of Korea
*shout@apcc21.org

APCC APEC CLIMATE CENTER

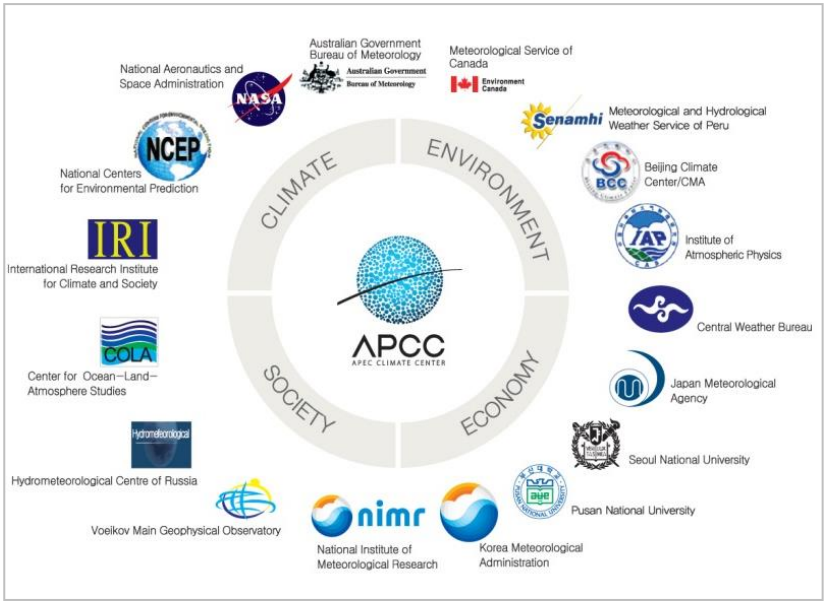
Mission

APCC

The mission of APCC is to enhance the socio-economic well-being of member economies by utilizing up-to-date scientific knowledge and applying innovative climate prediction techniques through

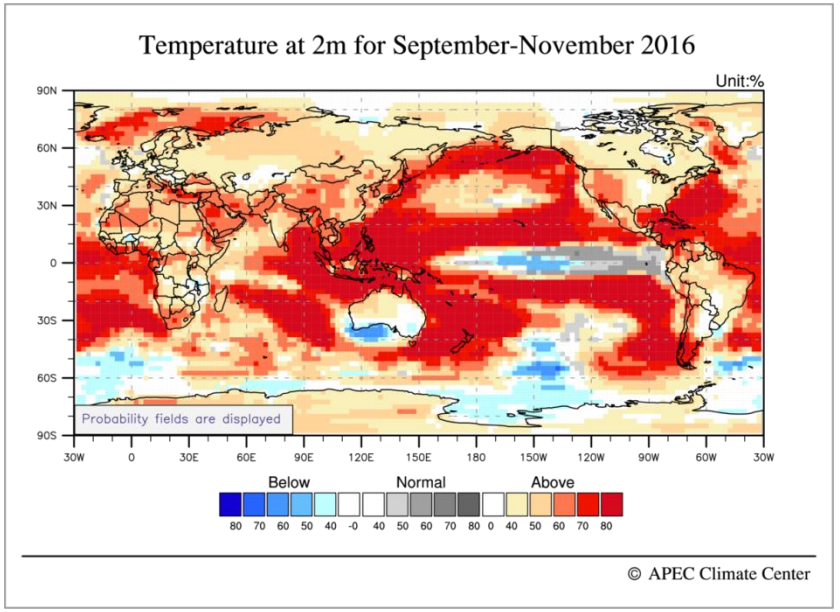
Climate Prediction

APCC produces value-added, reliable, and real-time climate prediction information and provides the APEC region with it.



Climate Information Services

APCC strives to be a key climate database center to distribute climate data, information products, and related tools.



MME Seasonal Forecast

Mission

APCC

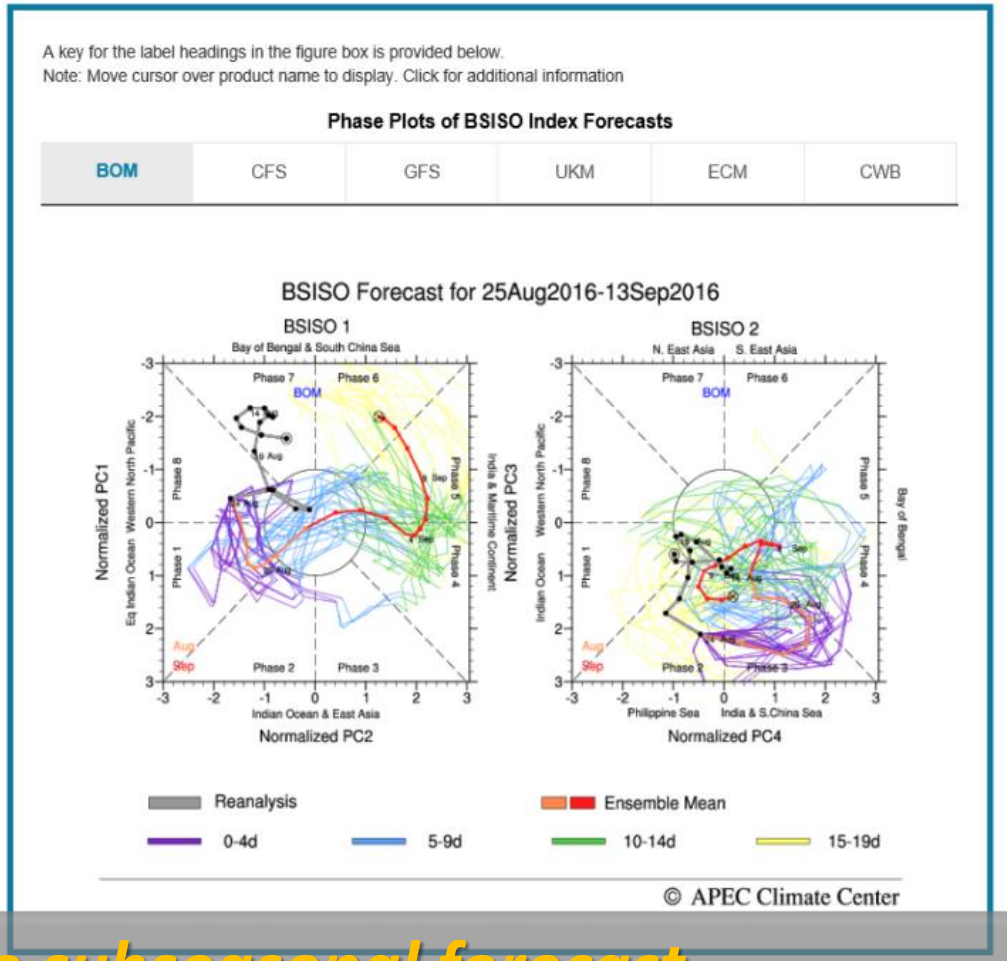
The mission of APCC is to enhance the socio-economic well-being of member economies by utilizing up-to-date scientific knowledge and applying innovative climate prediction techniques through

Climate Prediction

APCC produces value-added, reliable, and real-time climate prediction information and provides the APEC region with it.

Climate Information Services

APCC strives to be a key climate database center to distribute climate data, information products, and related tools.



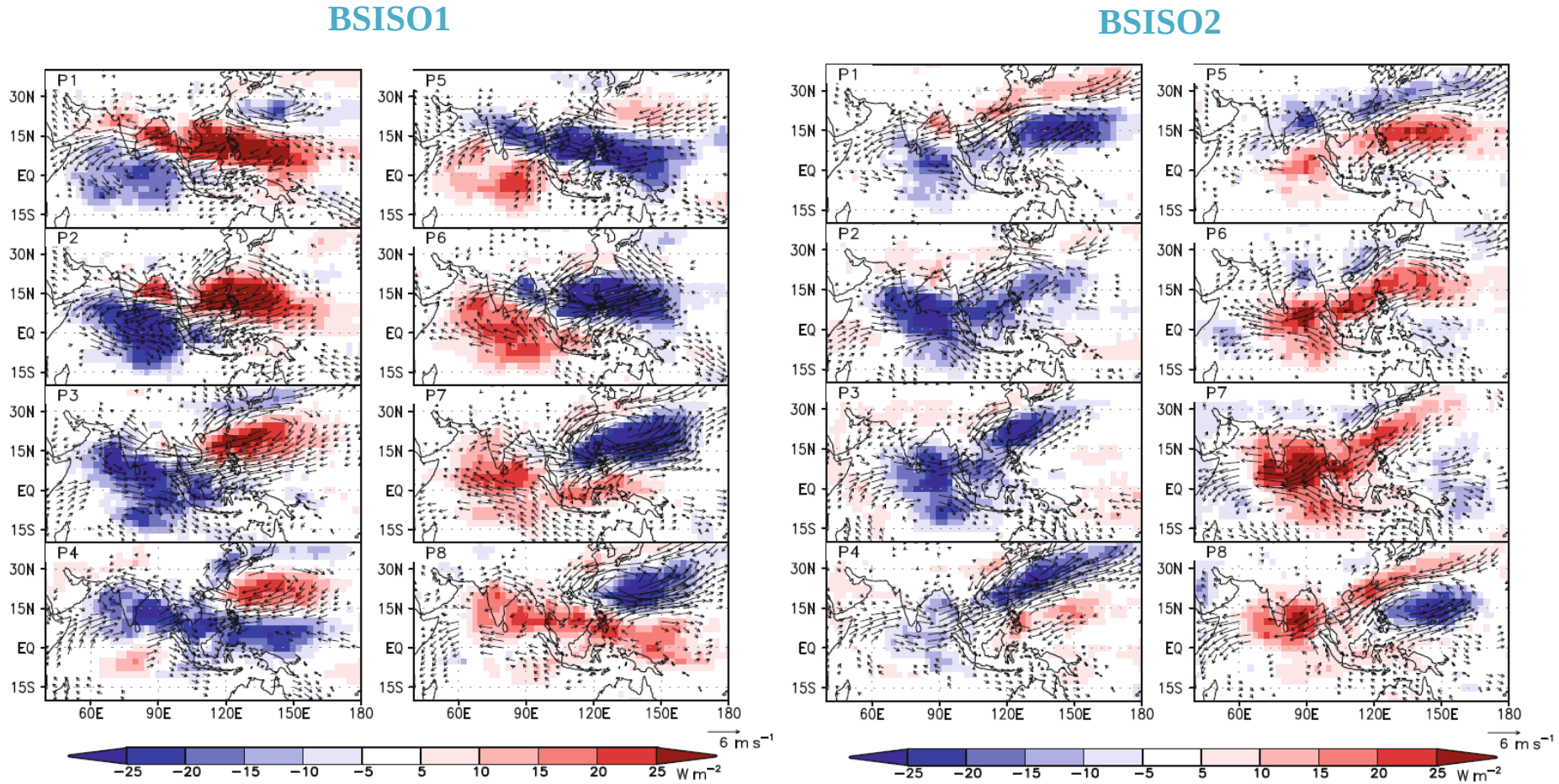
Expansion into subseasonal forecast

by providing BSISO real-time forecasts for the next 20 days.

Every day update with the latest information

Available from May to October at http://www.apcc21.org

Applied the Lee et al. (2013) BSISO index



BSISO has prominent ***northward or northwestward propagation*** and different oscillating period.

Lee et al(2013)'s indices not only can capture these complicated characteristic but also is ***useful for real-time monitoring/forecast.***

The wet and dry spells of the BSISO ***strongly influence extreme hydro-meteorological events***, major driving forces of natural disasters.

Participating models

in cooperation with MJO Task Force

Institute	Model	Ensemble Size	Forecast Period	Update frequency	Resolution
NCEP	Climate Forecast System	4	40 days	Once a day	T126 L64
	Global Forecast System	1	16 days	Once a day	T574, T190 L64
Australia	POAMA 2.4 multi-week model	33	40 days	Twice per week	T47 L17
ECMWF	ECMWF Ensemble Prediction System	51	32 days	Twice per week	T639, T319 L62
CWB	CWB EPS T119	6	40 days	Every 5 days	*T119 L30*

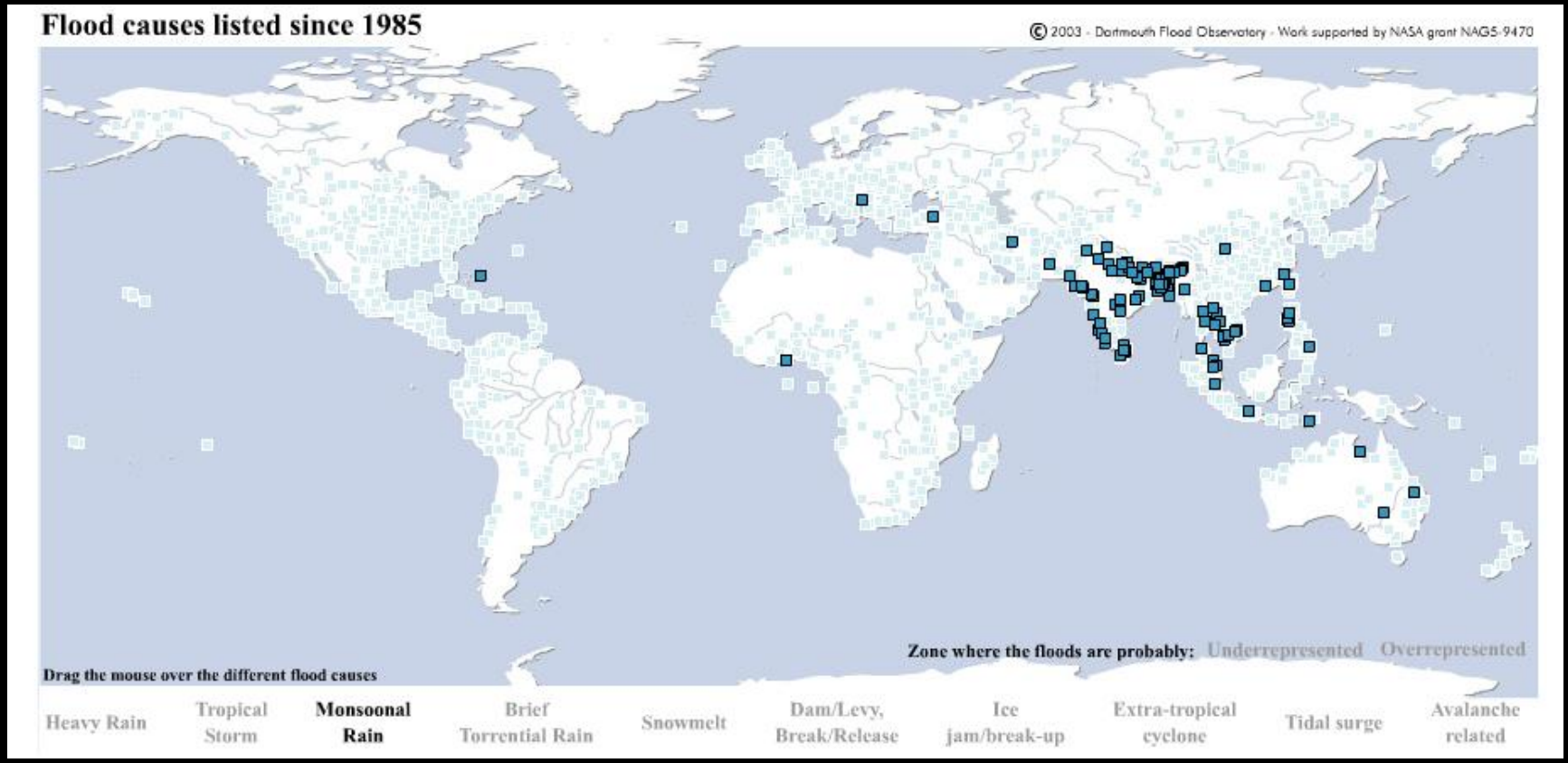
Under operational perspective

To promote practical use of real-time BSISO information

1. *Reliable forecast*
2. *Actionable information*

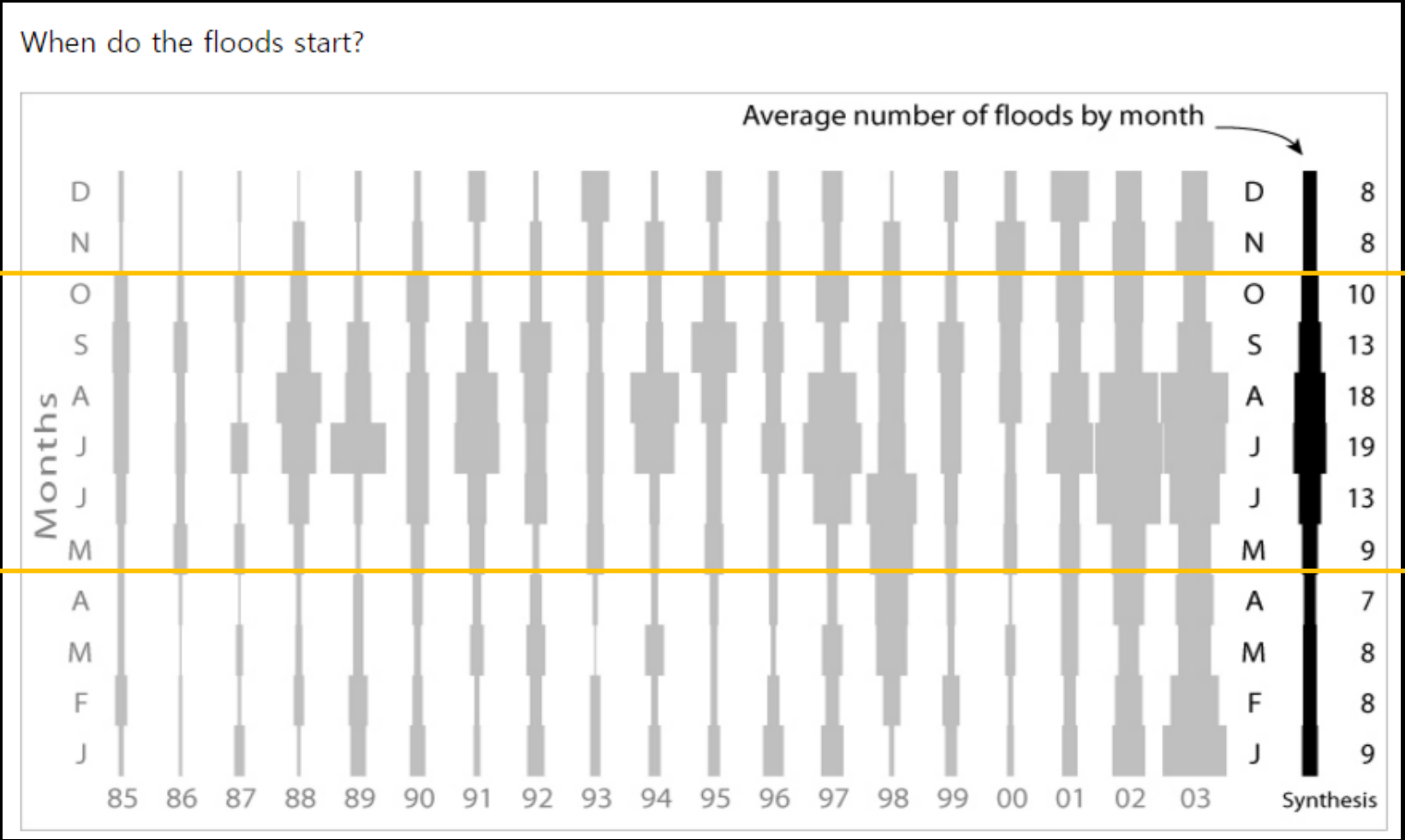
: in order to improve the capability to cope with extreme events for the developing countries in the Asia-Pacific region.

What is the actionable information for?



A lot of ***flooding*** is caused by heavy rain, tropical storm and monsoonal rain . Those are ***considerably associated with the BSISO activity.***

What is the actionable information for?



Objectives

Under operational perspective

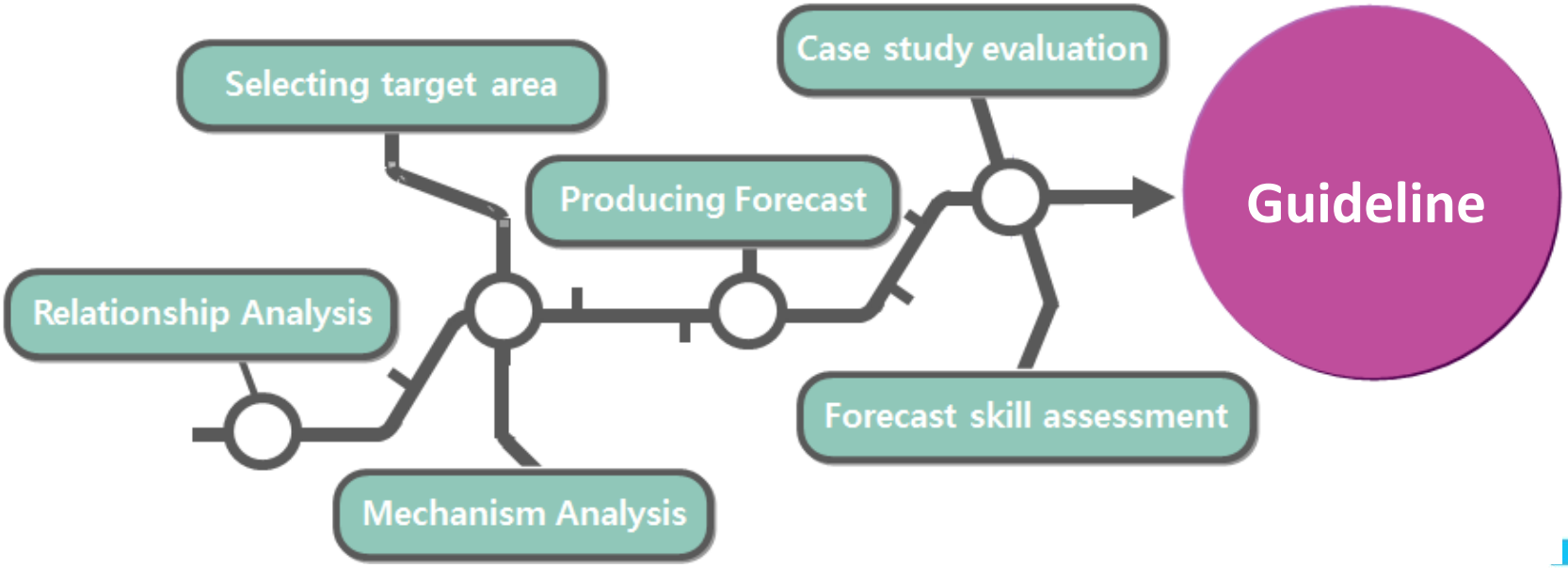
#1. BSISO impact on heavy rainfall

#2. Guideline for the practical use and interpretation of BSISO forecast information

: Focused on the ***flood prone areas with large rivers over Southeast Asia***

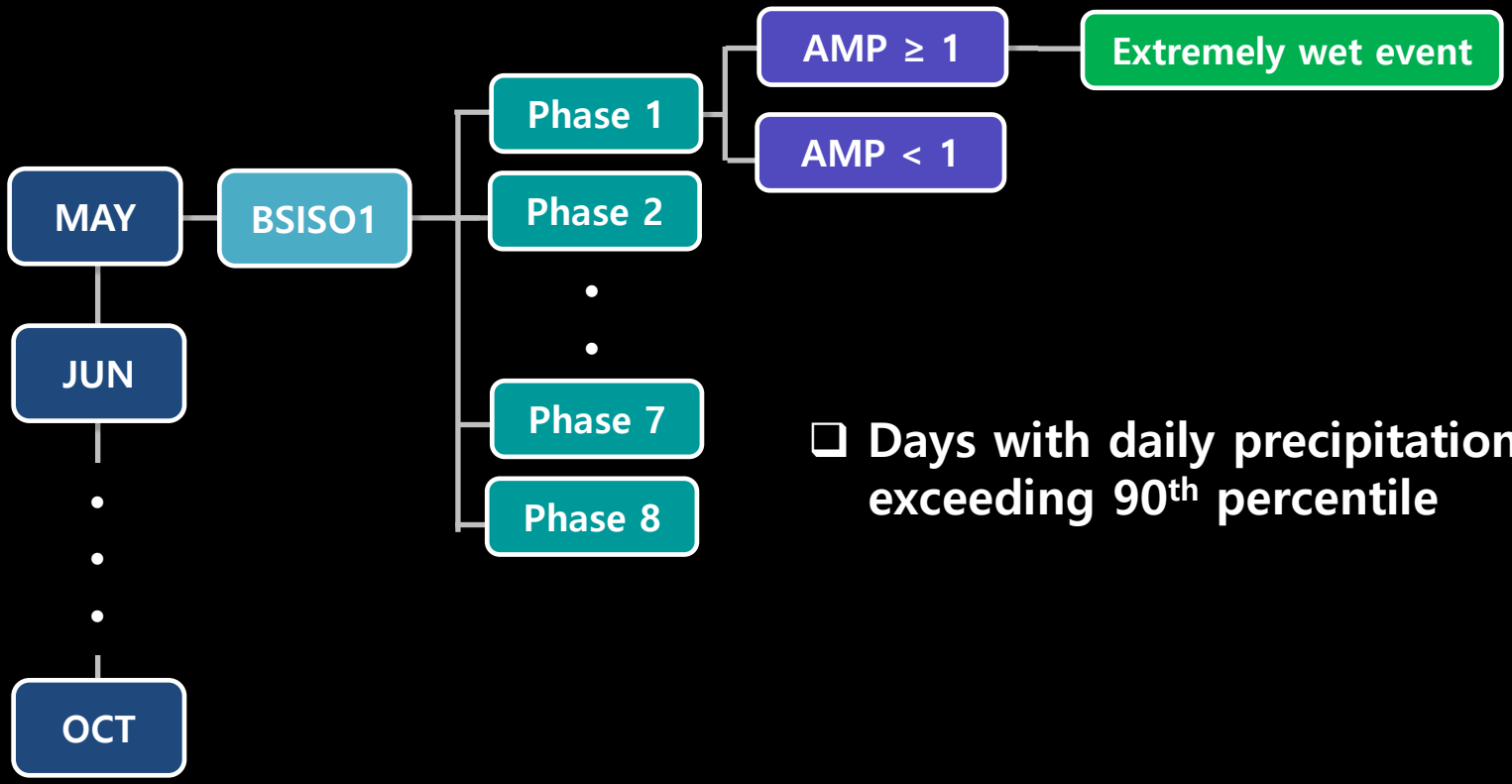
Strategy

'15 '16



Relationship analysis

Composite analysis : BSISO-Heavy rainfall probability



❑ Days with daily precipitation exceeding 90th percentile

Probability of heavy rainfall occurrence estimated by BSISO phases & amplitude

$$= \frac{\text{number of days } [\text{BSISO1}_{\text{AMP}} \geq 1,\ \text{BSISO1 phase1},\ \text{daily PRCP} > 90th\ percentile]}{\text{number of days } [\text{BSISO1}_{\text{AMP}} \geq 1,\ \text{BSISO1 phase1}]} \times 100$$

Lee et al. (2017). Subseasonal prediction of extreme precipitation over Asia: Boreal summer intraseasonal oscillation perspective, J. Climate, 30(8), DOI: 10.1175/JCLI-D-16-0206.1

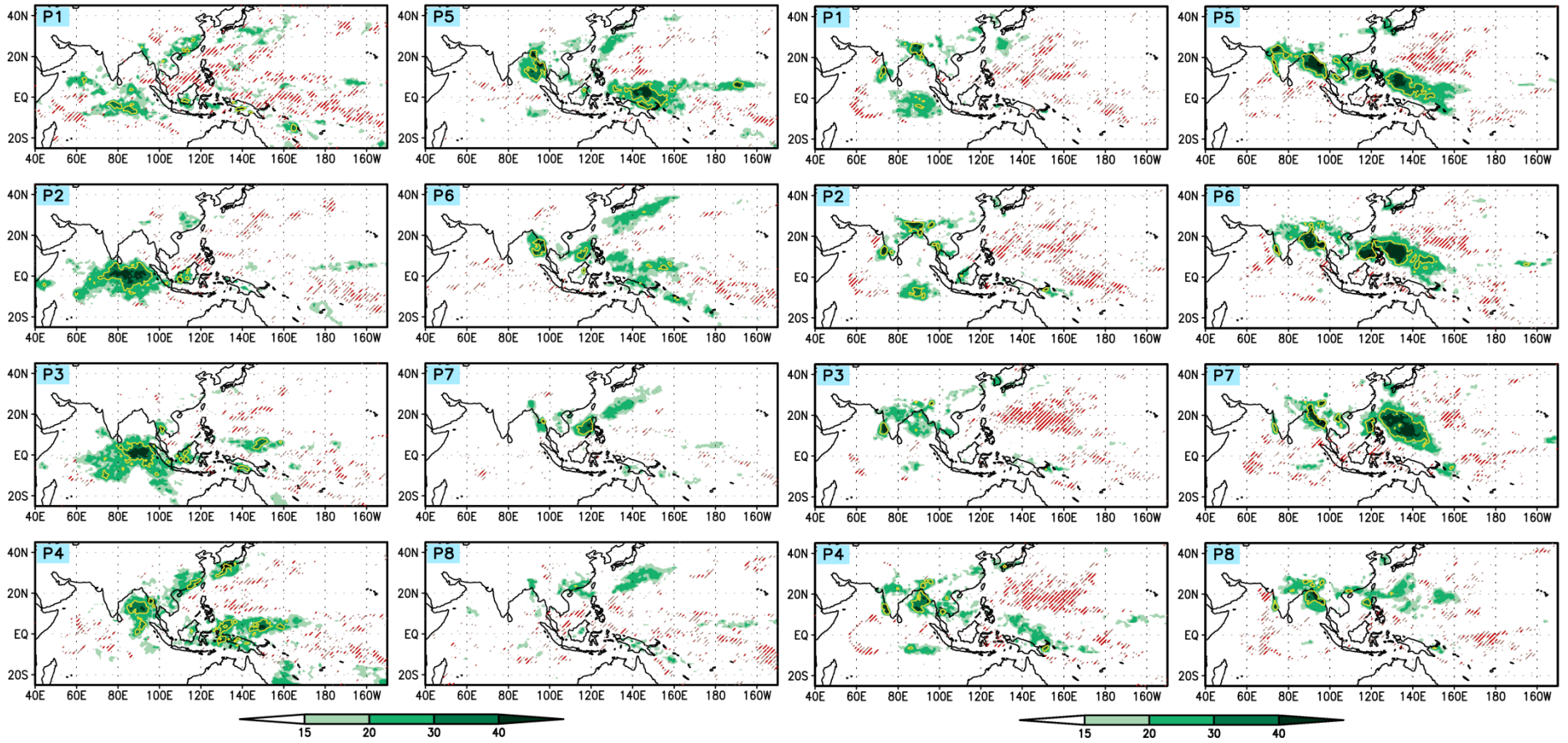
Relationship analysis

Composite analysis : BSISO-Heavy rainfall probability

Probability of extreme rainfall occurrence based on BSISO phases

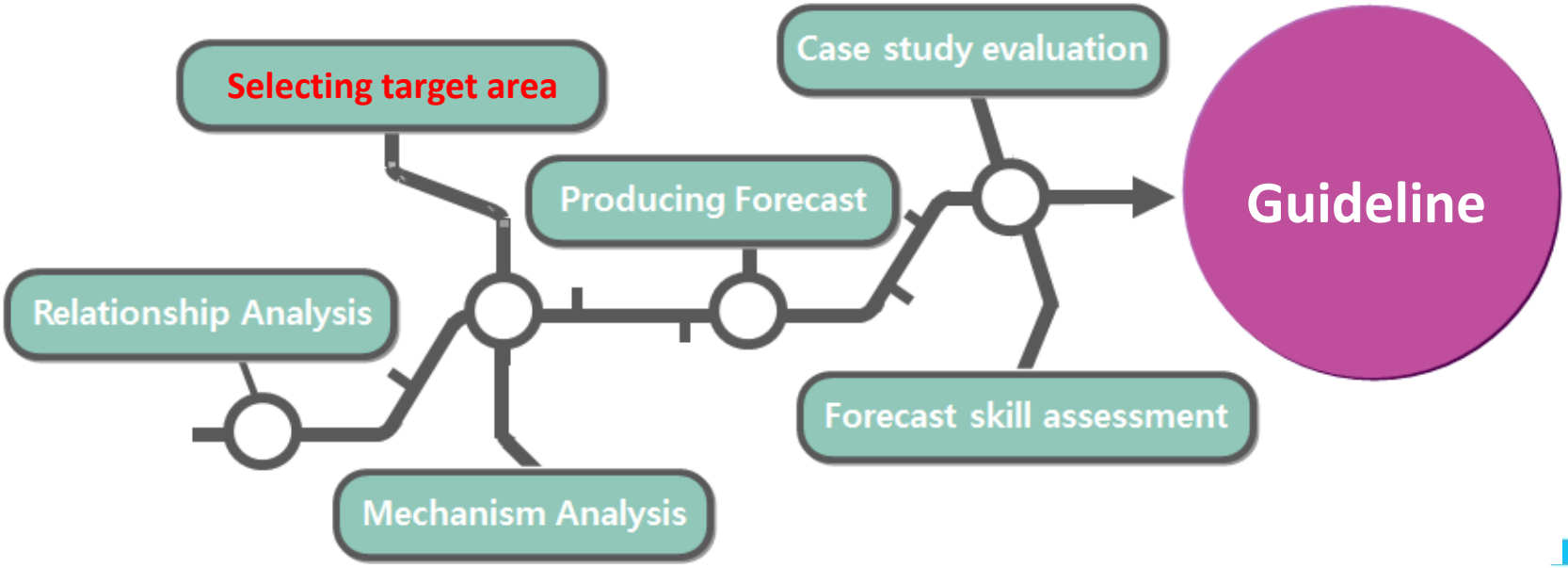
[e.g.MAY, BSISO1>=1.0]

[e.g.JUL, BSISO2>=1.0]



Strategy

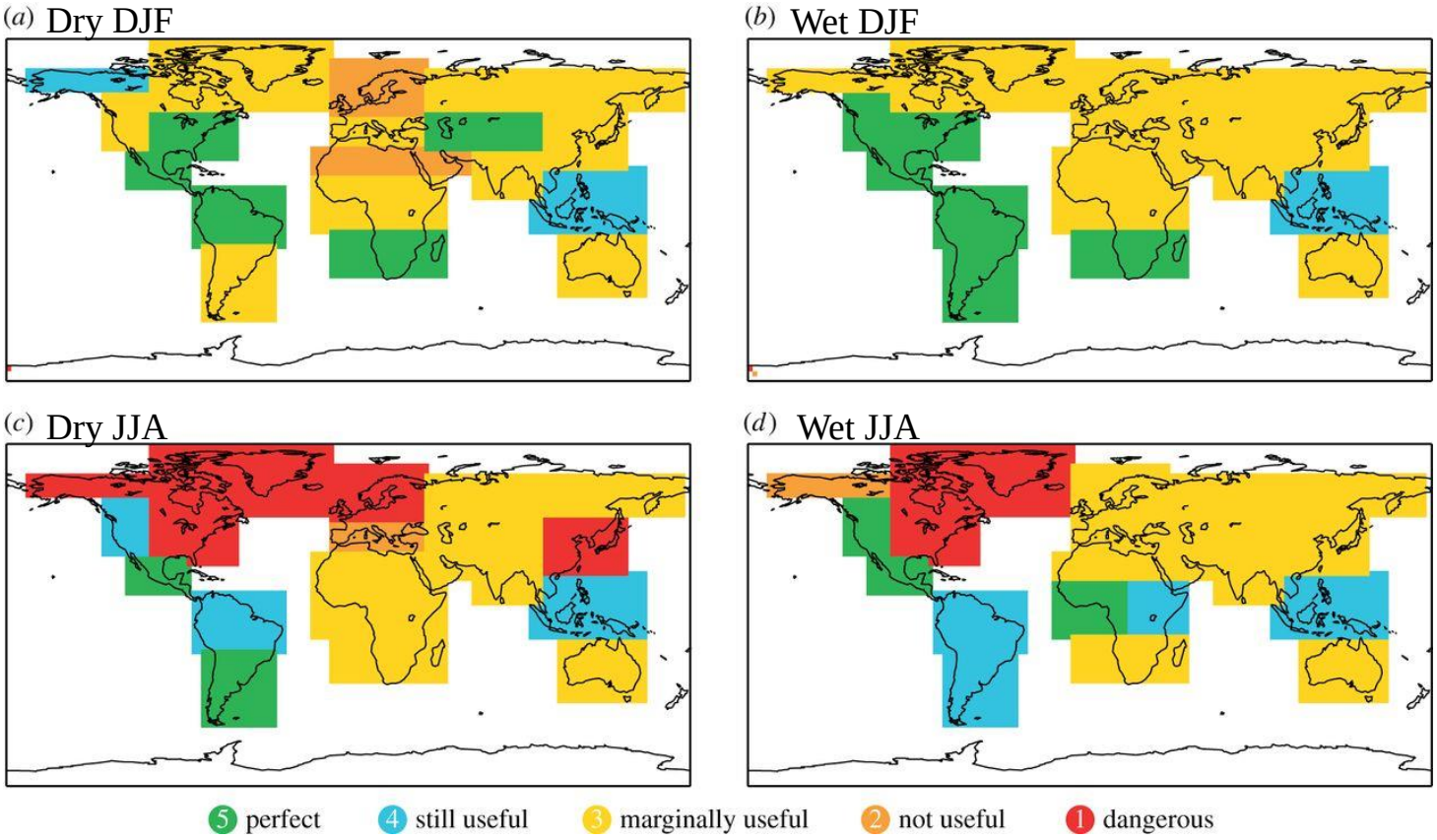
‘15 ‘16



Selecting target area

#R1. Developing countries in the APEC region
#R2. Predictable region from the view of meteorologist

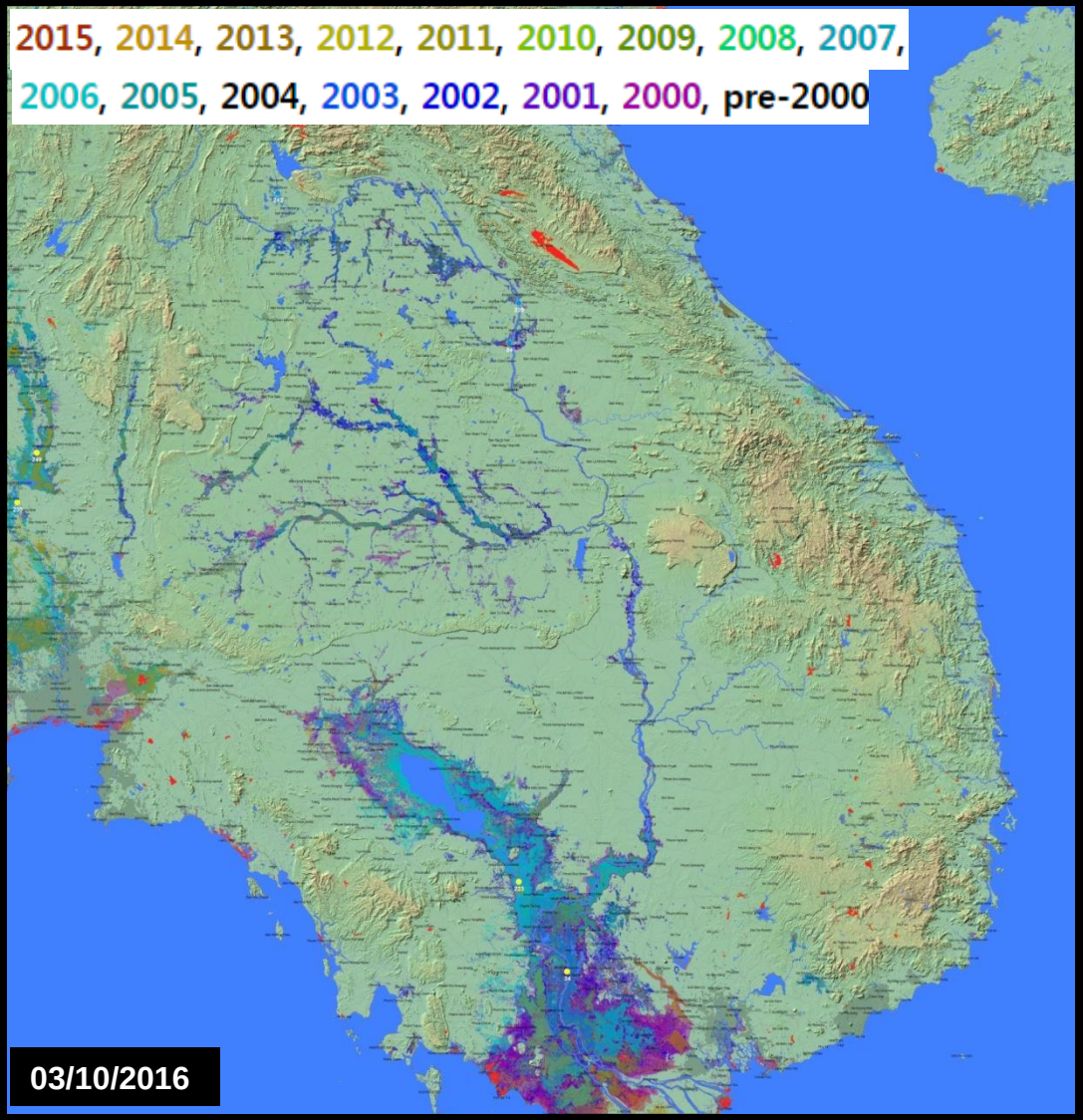
Reliability categorization of precipitation forecasts



The skill over ***Southeast Asia*** is useful.
It is consistent among the events and seasons.

A. Weisheimer, and T. N. Palmer, J. R. Soc. Interface 2014;11:20131162

Selecting target area

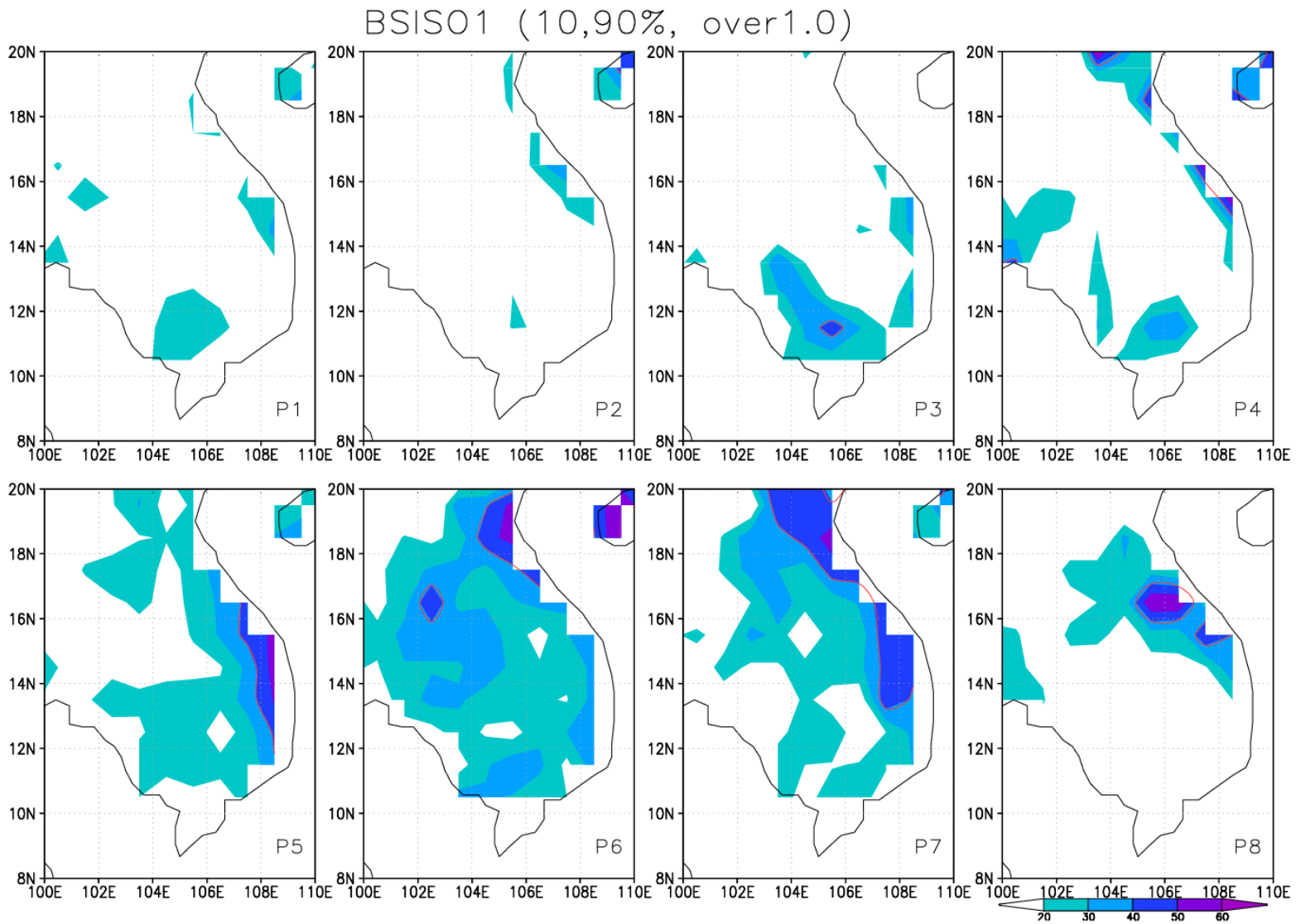


#R3. Flood prone areas with large rivers from the view of hydrologist

http://floodobservatory.colorado.edu

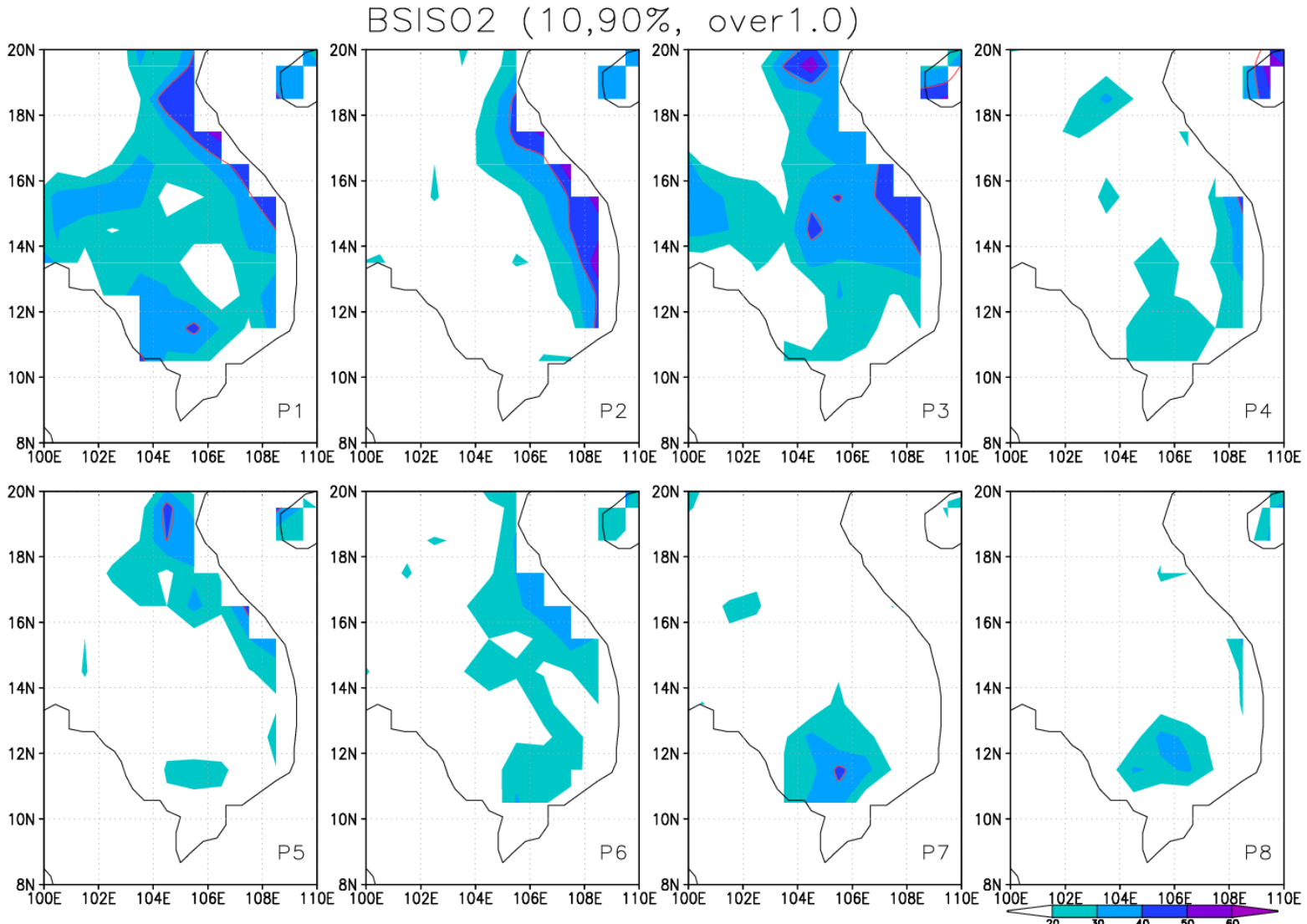
Relationship analysis

Composite analysis : BSISO-Heavy rainfall probability



Relationship analysis

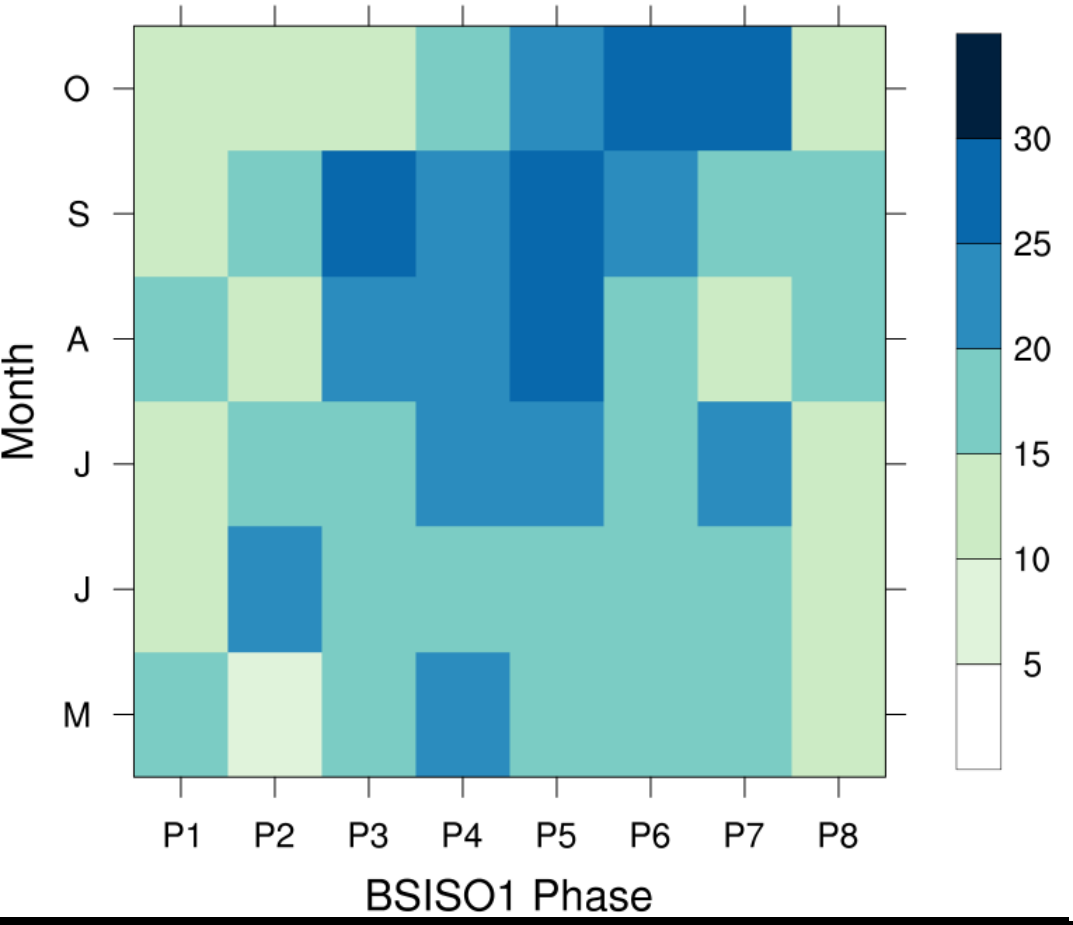
Composite analysis : BSISO-Heavy rainfall probability

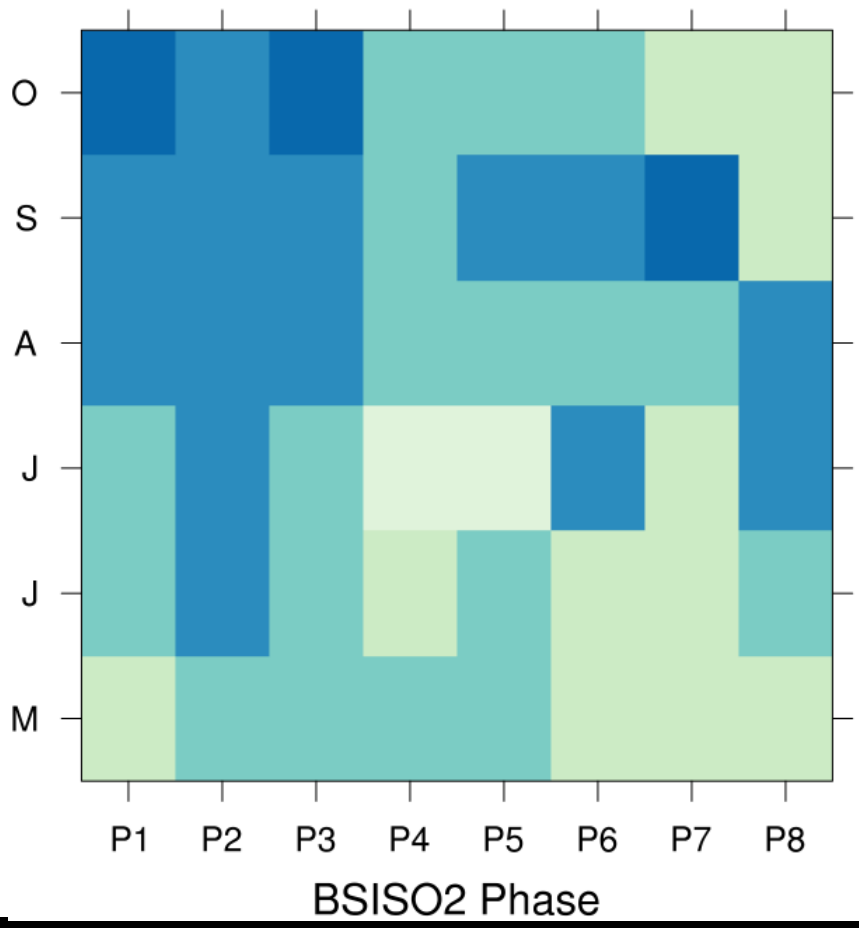


Relationship analysis

Composite analysis : BSISO-Heavy rainfall probability

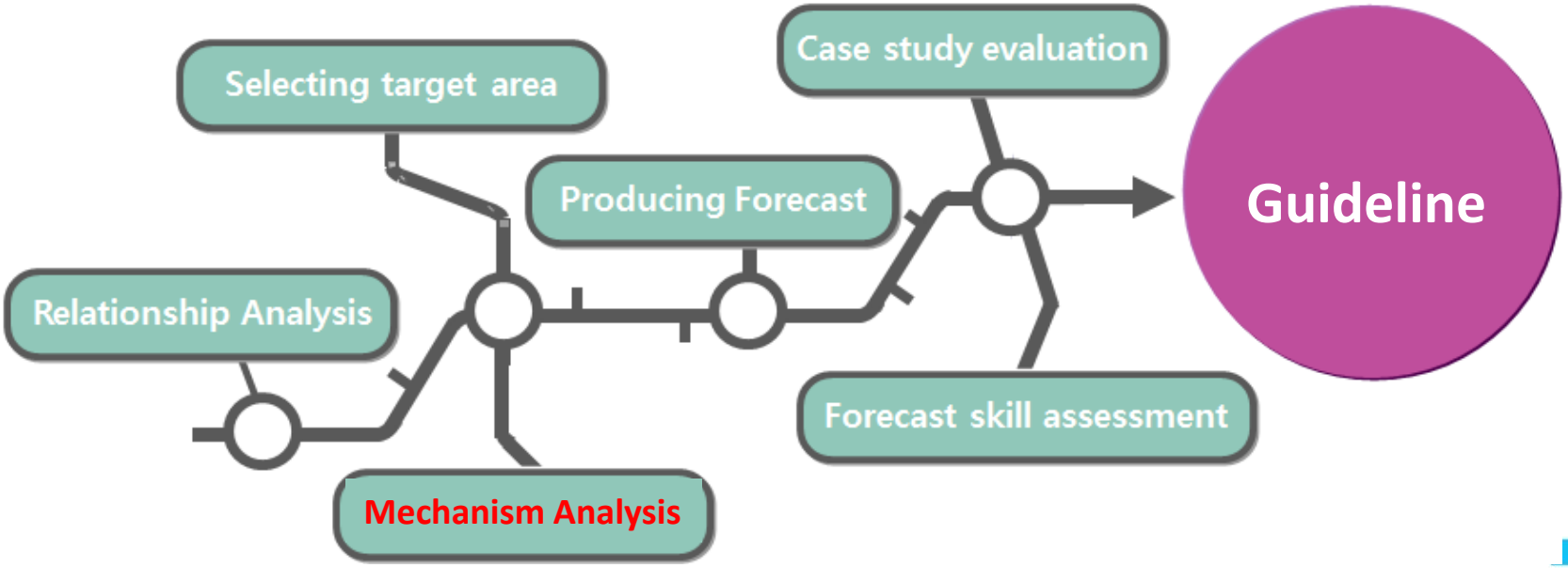
Probability of Heavy Rainfall occurrence [Mekong River]





Strategy

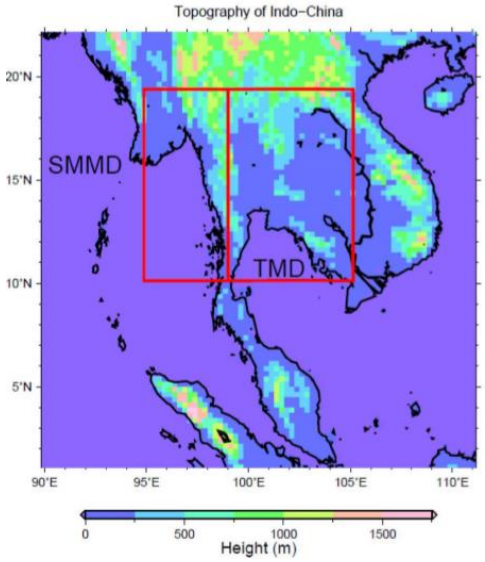
'15 '16



Mechanism Analysis

BSISO-Extreme rainfall probability

Because the precipitation in Thailand is ***influenced by local monsoon winds*** rather than Indian monsoon or WNP monsoon, a new set of indices incorporating these winds was explored and these four indices are named the ***Indo-China Monsoon Indices (ICMIs).*** These ICMIs ***better explain the rainfall*** over Thailand monsoon domain***.***



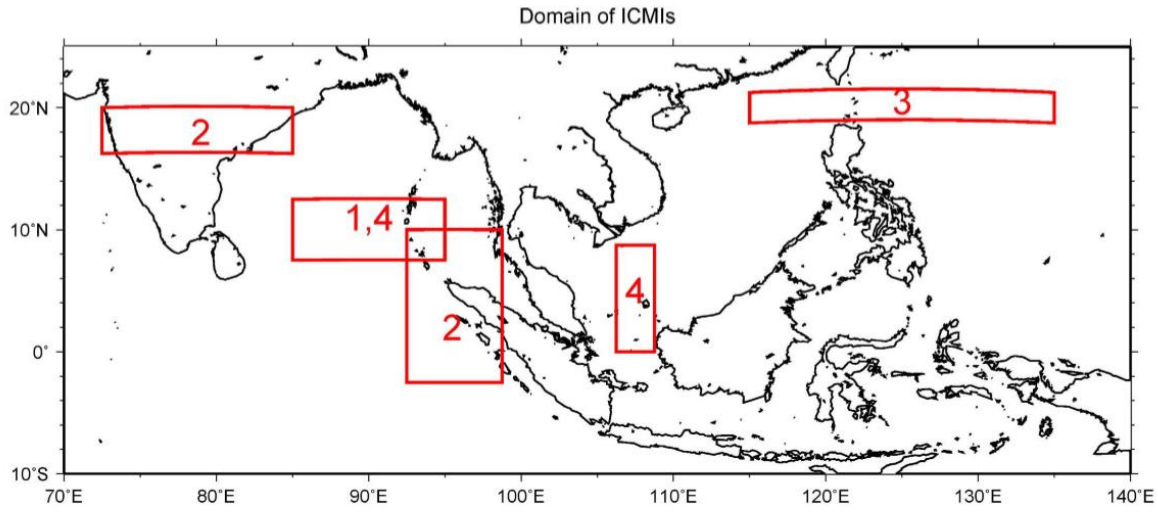


Figure 8 | Domain of ICMIs. The boxes represent the domains of ICMIs and the numbers represent the type of ICMIs.

Tsai, C., Behera, S.K. & Waseda, T. (2015). Indo-China Monsoon Indices. Sci. Rep. 5, 8107; DOI:10.1038/srep08107

Mechanism Analysis

BSISO-Extreme rainfall probability

[MAM] TMD are influenced by the developing phase of the Southeastern Asian Summer Monsoon. This monsoon early signal can be detected ***from the changing zonal wind east of Sri Lanka***.
[JJA] The strengthening of ***the easterlies east of Hainan Island*** brings extra precipitation to TMD.
[SON] Normal/slow decaying Southeastern Asian Summer Monsoon and ***southerlies in south of Vietnam*** are necessary to bring extra precipitation to TMD.

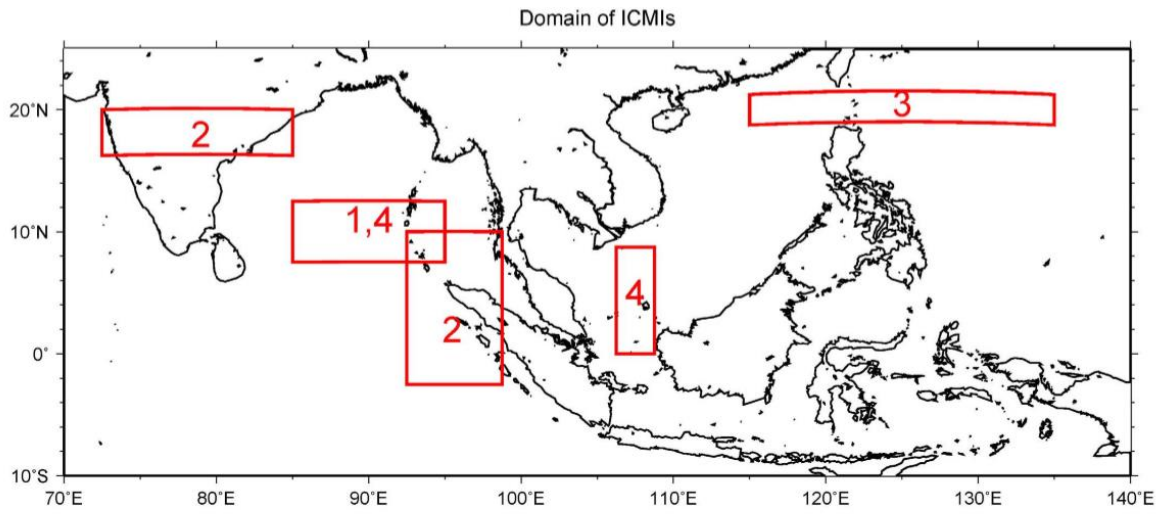
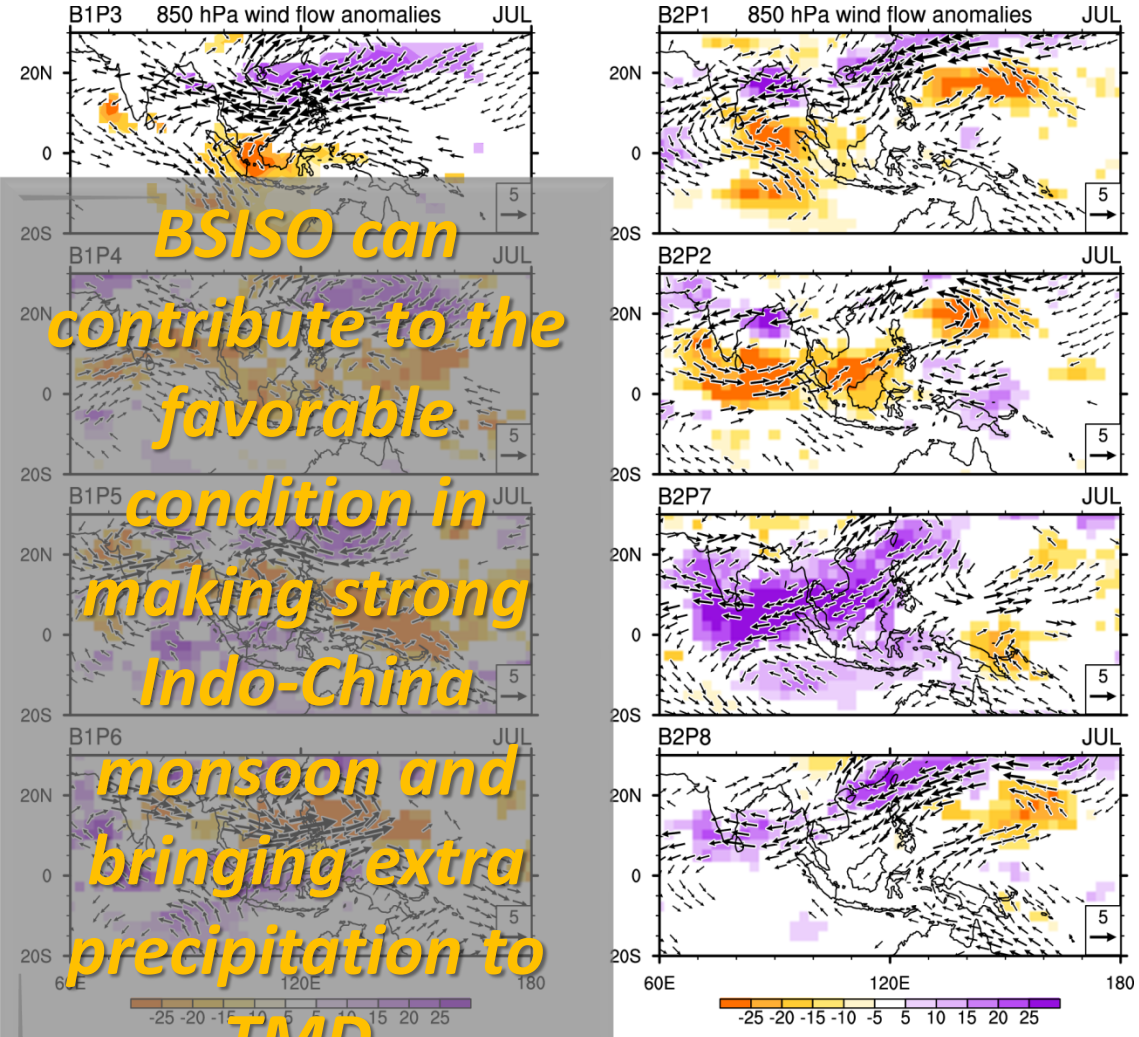
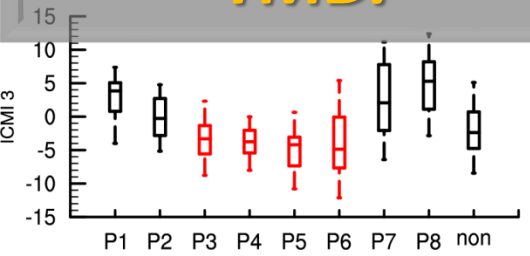


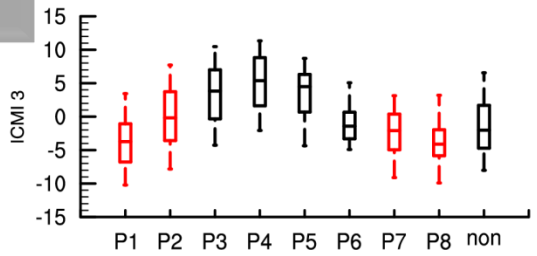
Figure 8 | Domain of ICMIs. The boxes represent the domains of ICMIs and the numbers represent the type of ICMIs.

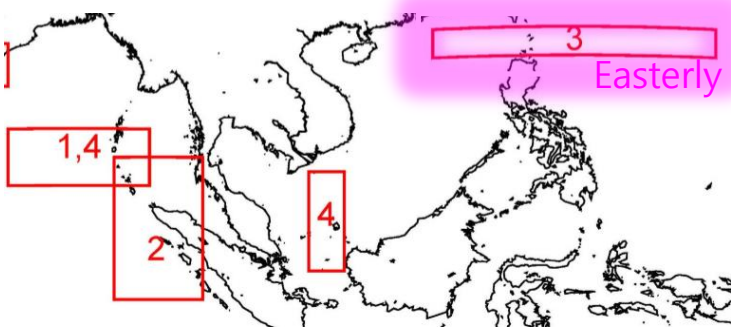
Tsai, C., Behera, S.K. & Waseda, T. (2015). Indo-China Monsoon Indices. Sci. Rep. 5, 8107; DOI:10.1038/srep08107

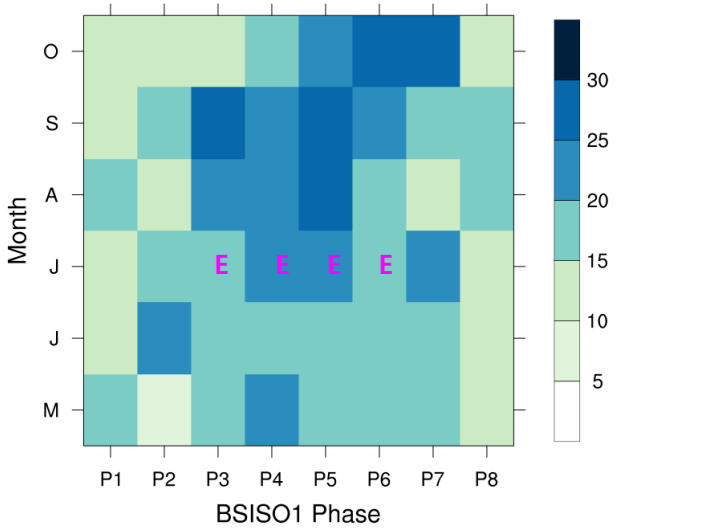


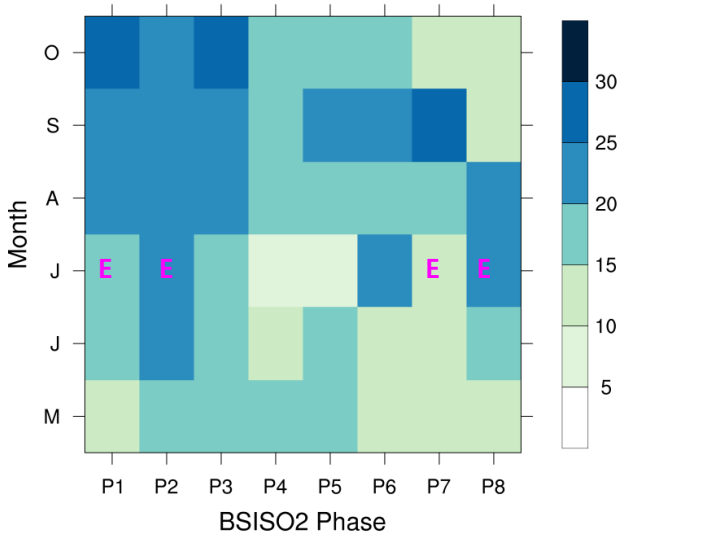
BSISO can contribute to the favorable condition in making strong Indo-China monsoon and bringing extra precipitation to TMD.

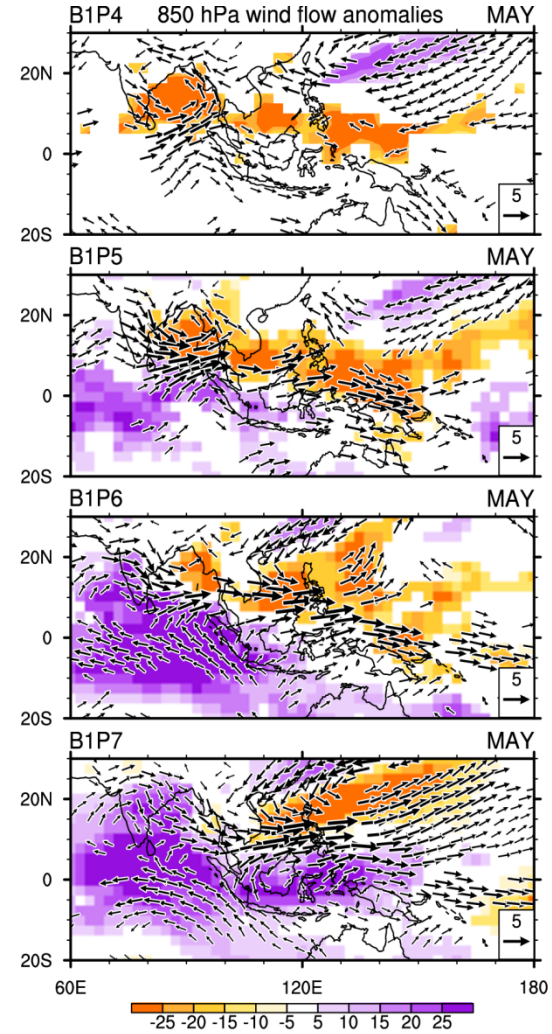


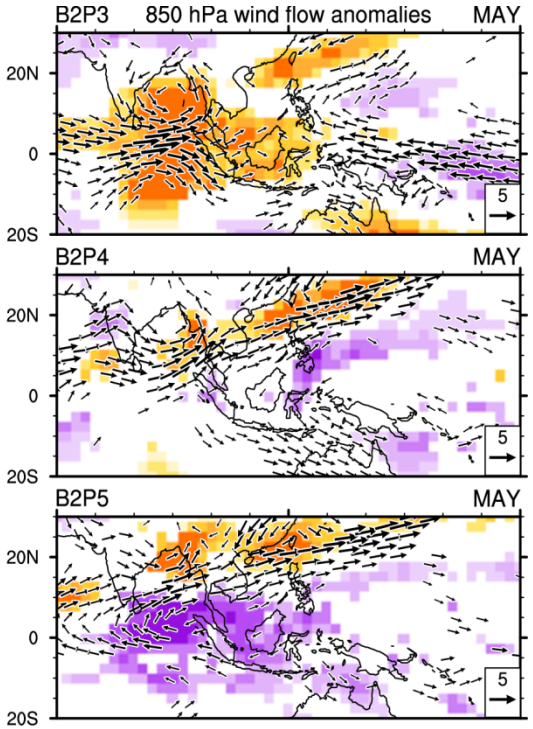


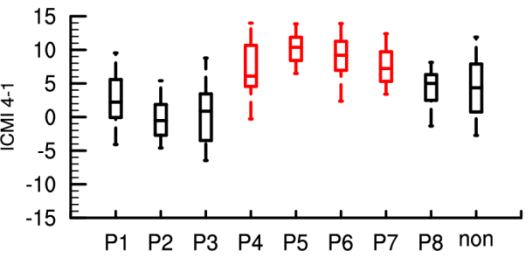


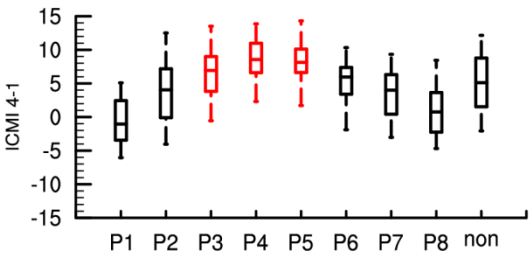


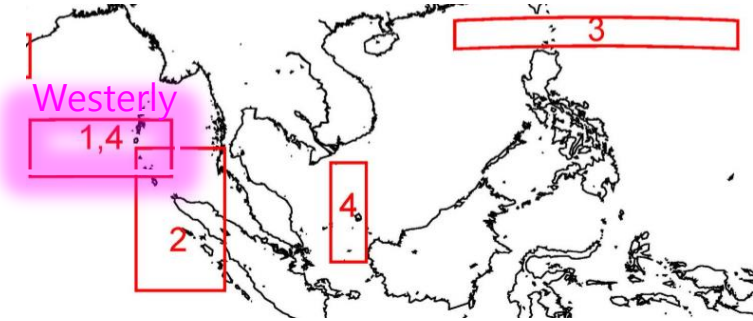


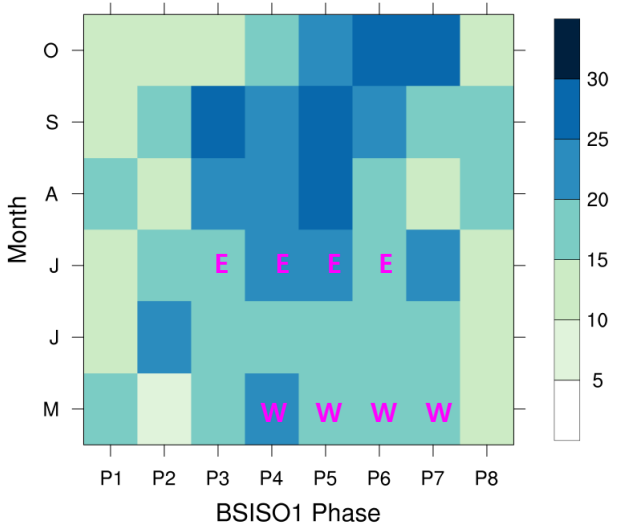

B1P4 850 hPa wind flow anomalies MAY
B1P5 MAY
B1P6 MAY
B1P7 MAY
20N
0
20S
5
60E
120E
180
-25 -20 -15 -10 -5 5 10 15 20 25

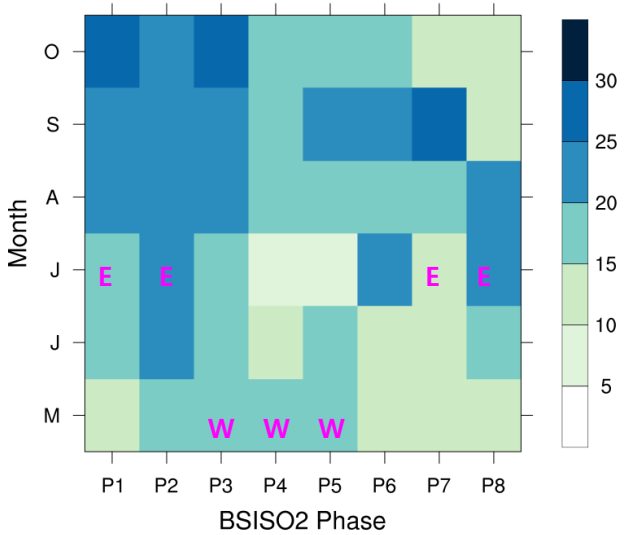

B2P3 850 hPa wind flow anomalies MAY
B2P4 MAY
B2P5 MAY
20N
0
20S
5

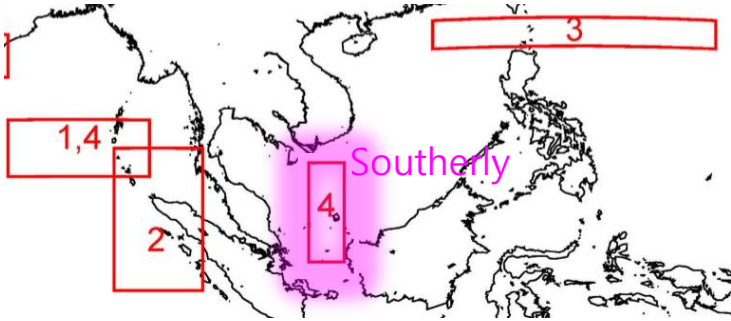

ICMI 4-1
15
10
5
0
-5
-10
-15
P1 P2 P3 P4 P5 P6 P7 P8 non

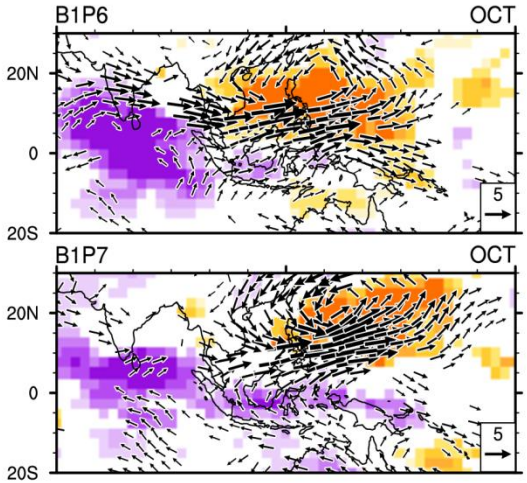

ICMI 4-1
15
10
5
0
-5
-10
-15
P1 P2 P3 P4 P5 P6 P7 P8 non

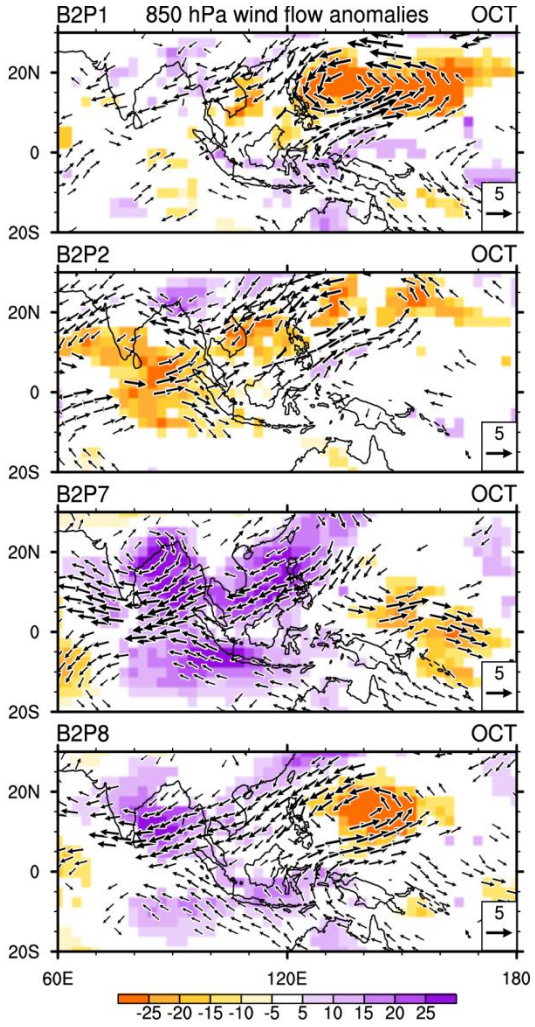

Westerly
1,4
2
3
4

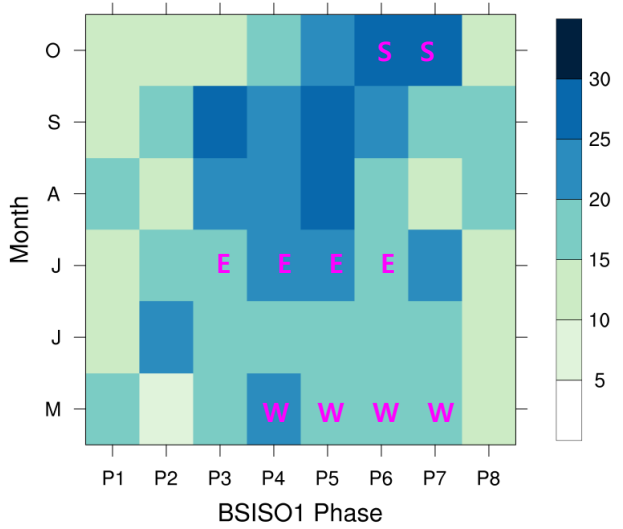

Month
O
S
A
J
J
M
E E E E
W W W W
P1 P2 P3 P4 P5 P6 P7 P8
BSISO1 Phase
30
25
20
15
10
5

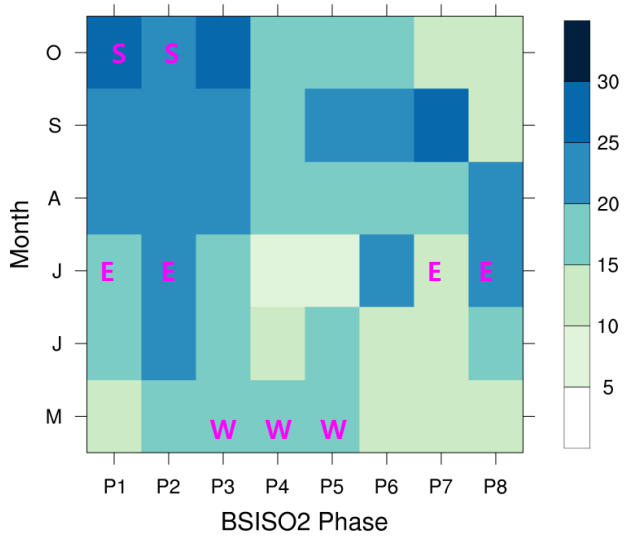

Month
O
S
A
J
J
M
E E E E
W W W
P1 P2 P3 P4 P5 P6 P7 P8
BSISO2 Phase
30
25
20
15
10
5

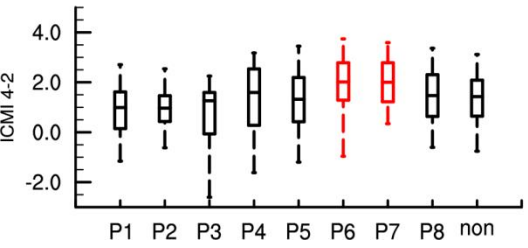

3
1,4
2
4
Southerly

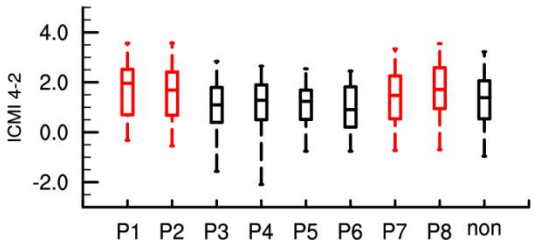

B1P6
OCT
B1P7
OCT
20N
0
20S
5


B2P1
850 hPa wind flow anomalies
OCT
B2P2
OCT
B2P7
OCT
B2P8
OCT
20N
0
20S
5
60E
120E
180
-25 -20 -15 -10 -5 5 10 15 20 25


O
S
A
J
J
M
Month
S S
E E E E
W W W W
P1 P2 P3 P4 P5 P6 P7 P8
BSISO1 Phase
30
25
20
15
10
5

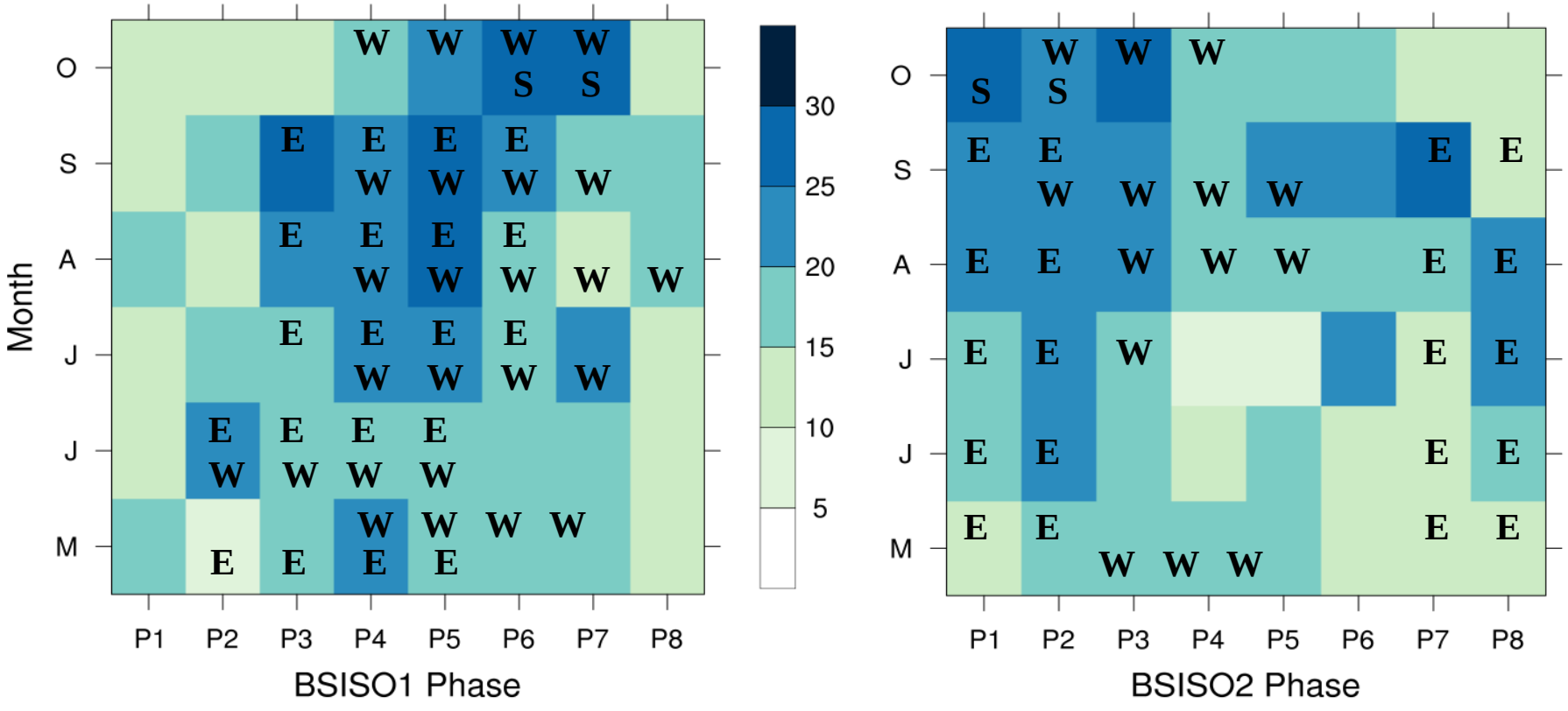

O
S
A
J
J
M
Month
S S
E E E E
W W W
P1 P2 P3 P4 P5 P6 P7 P8
BSISO2 Phase
30
25
20
15
10
5


ICMI 4-2
4.0
2.0
0.0
-2.0
P1 P2 P3 P4 P5 P6 P7 P8 non


ICMI 4-2
4.0
2.0
0.0
-2.0
P1 P2 P3 P4 P5 P6 P7 P8 non

Mechanism Analysis

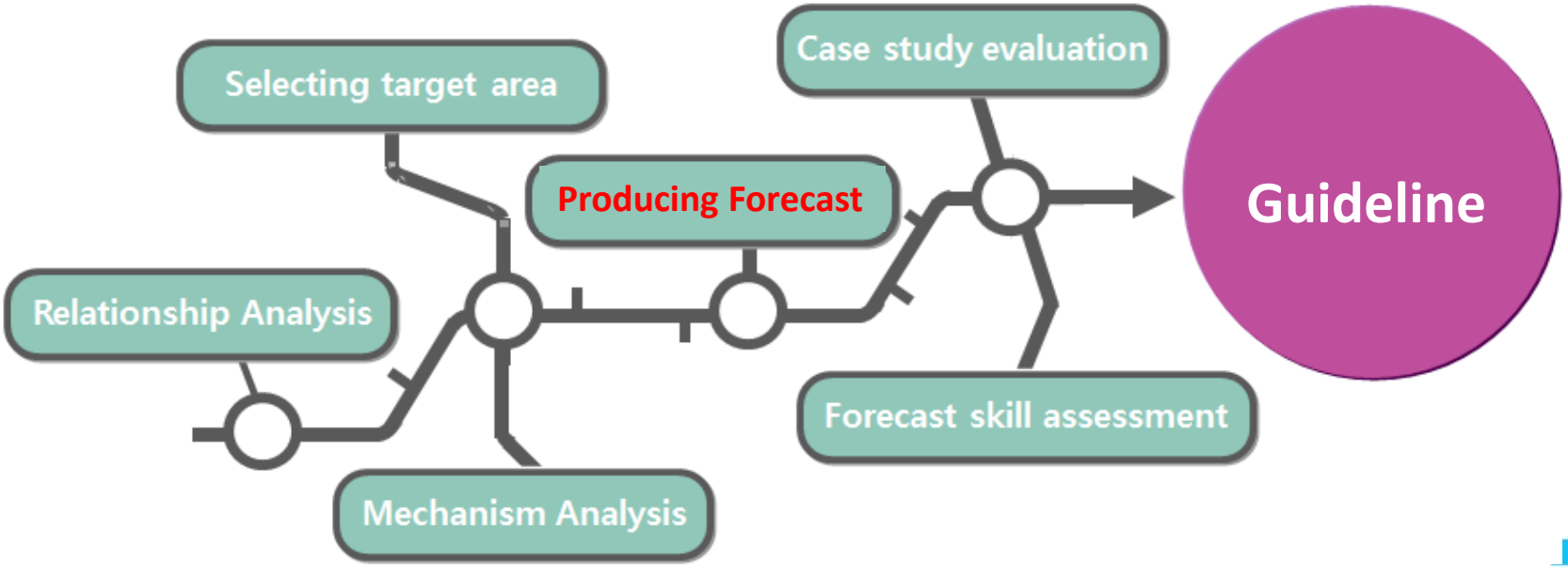
BSISO-Extreme rainfall probability



Probability table marked with favorable wind condition which can contribute strong Indo-China monsoon and bring heavy rainfall.

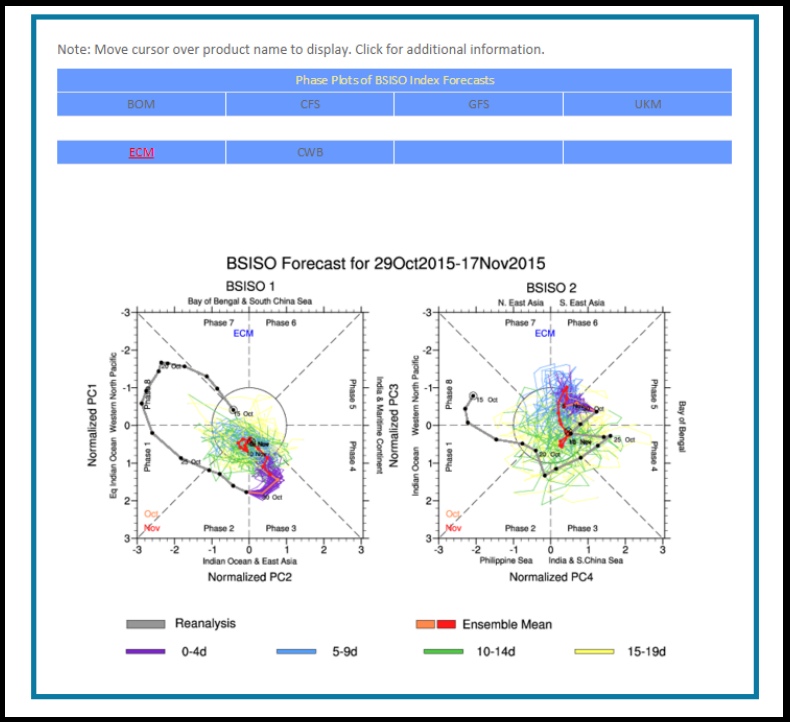
Strategy

'15 '16



Producing Forecasts estimated by BSISO indices

BSISO real-time forecast



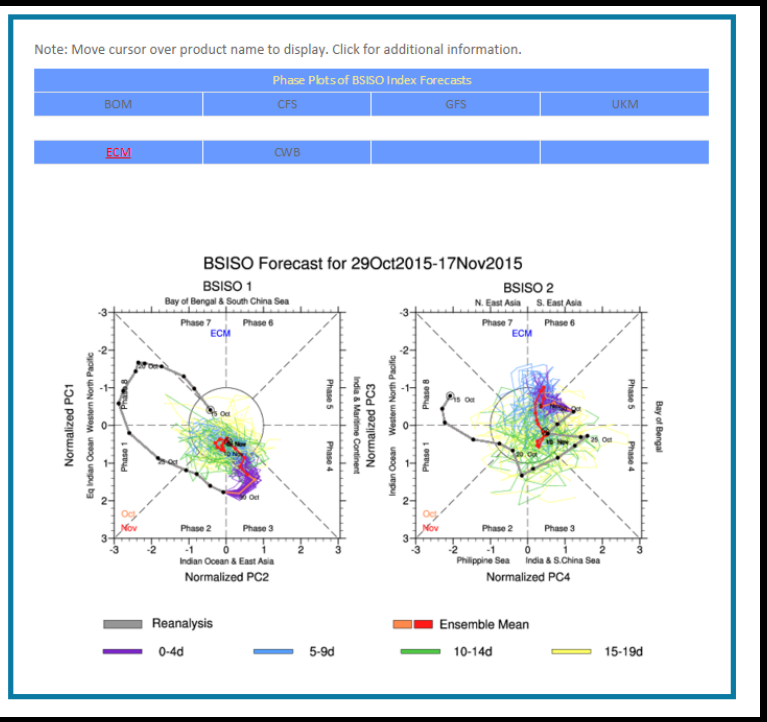
YEAR	DAY	BSISO1	BSISO2	B1phs	B2phs
2015	262	0.395	0.734	P3	P6
2015	263	0.154	0.753	P3	P6
2015	264	0.190	0.223	P3	P6
2015	265	0.600	0.833	P3	P6

BSISO forecast index =

f (Amplitude, Phase)

Producing Forecasts estimated by BSISO indices

BSISO real-time forecast

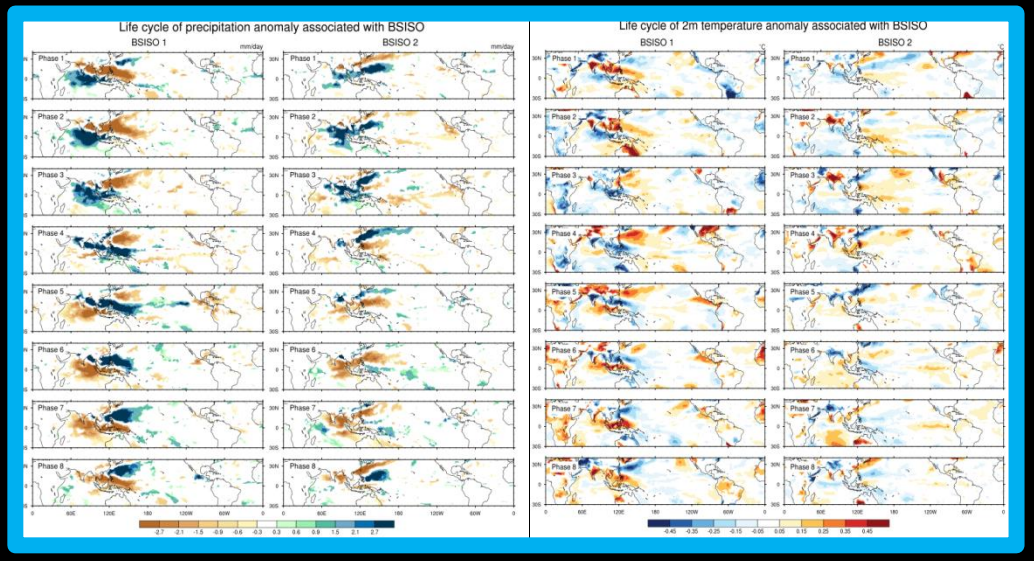


YEAR	DAY	BSISO1	BSISO2	B1phs	B2phs
2015	262	0.395	0.734	P3	P6
2015	263	0.154	0.753	P3	P6
2015	264	0.190	0.223	P3	P6
2015	265	0.600	0.833	P3	P6

BSISO forecast index =

f (Amplitude, Phase)

Observational relationship

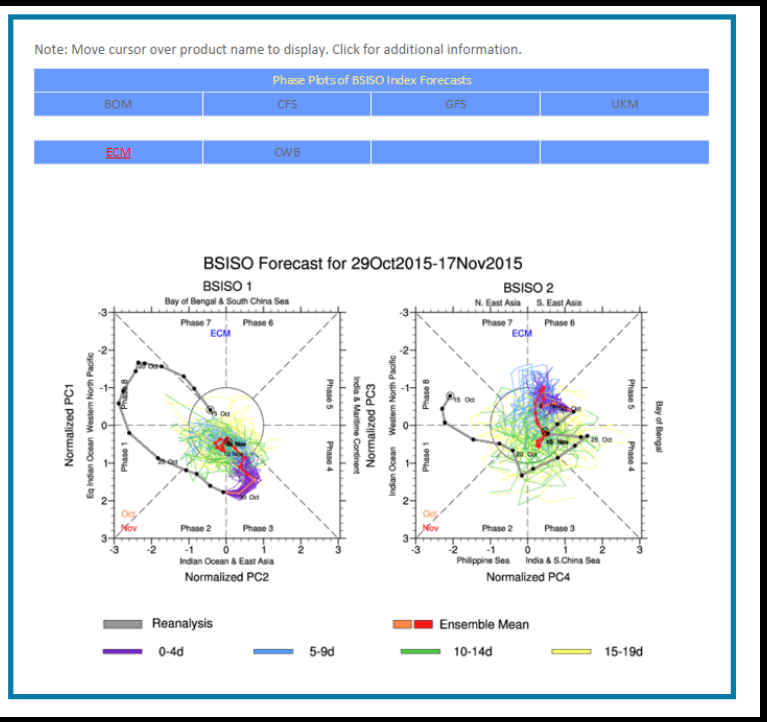


Composite Anomalies associated with the BSISO

[Mon, BSISO > 1.0]

Producing Forecasts estimated by BSISO indices

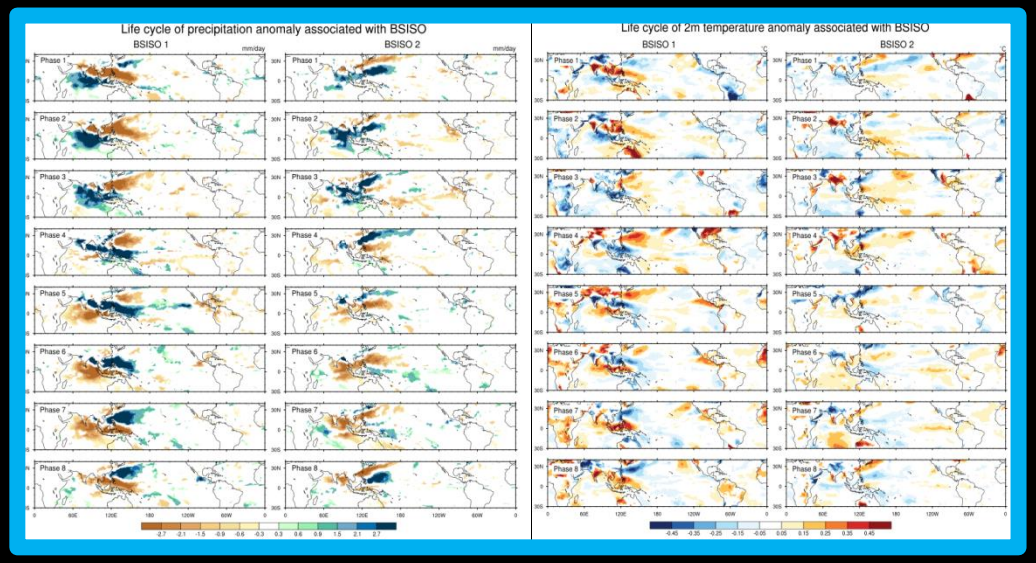
BSISO real-time forecast



YEAR	DAY	BSISO1	BSISO2	B1phs	B2phs
2015	262	0.395	0.734	P3	P6
2015	263	0.154	0.753	P3	P6
2015	264	0.190	0.223	P3	P6
2015	265	0.600	0.833	P3	P6

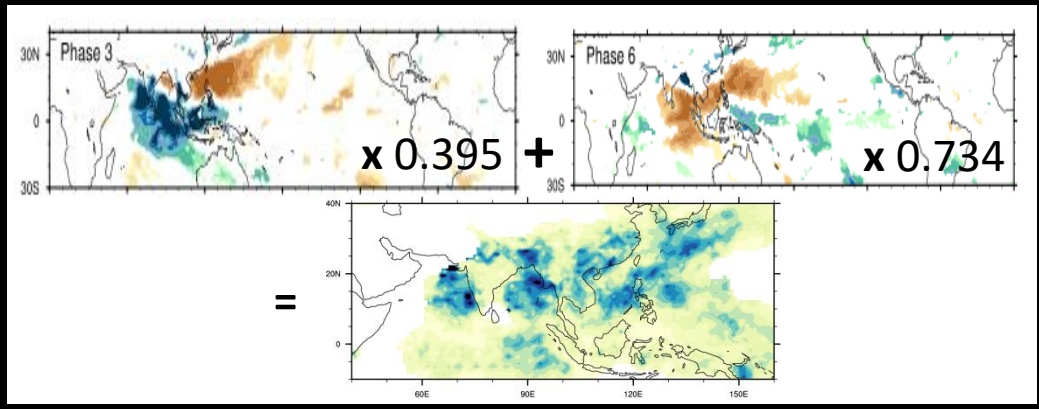
BSISO forecast index =
f (Amplitude, Phase)

Observational relationship



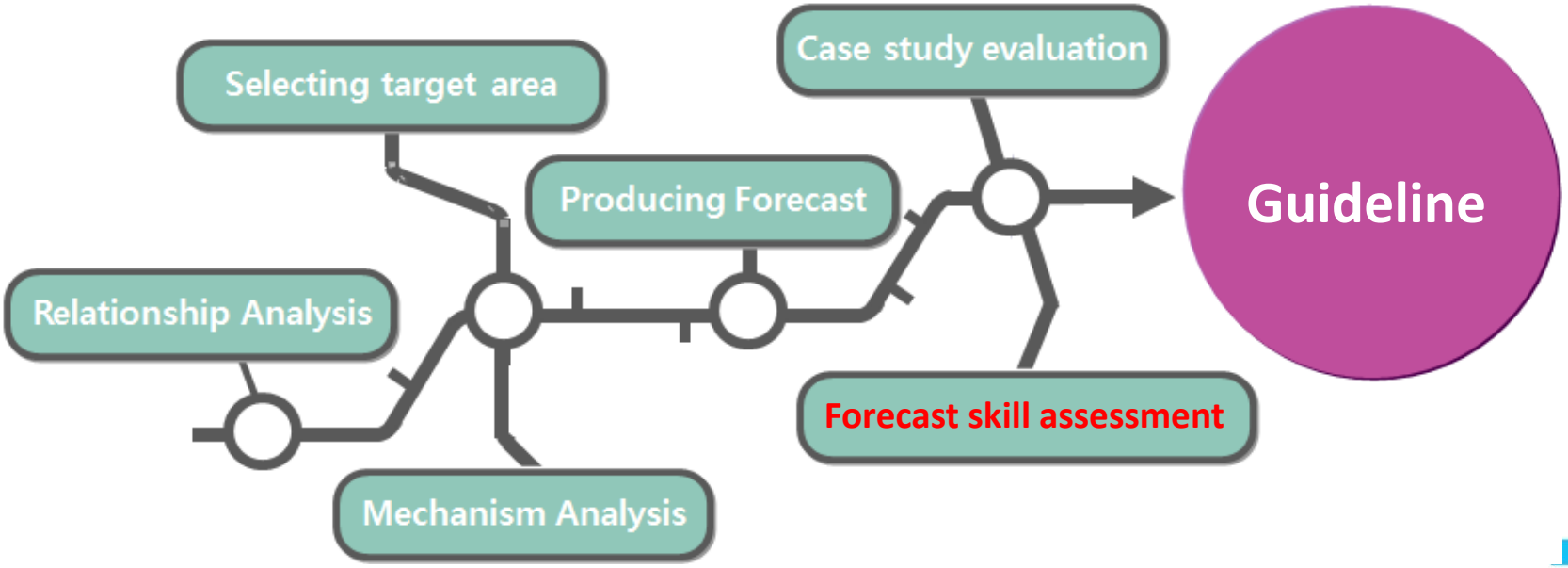
Composite Anomalies associated with the BSISO
[Mon, BSISO > 1.0]

Prediction of anomalies associated with the BSISO
(B1P3 x Amp$_{BSISO1}$ + B2P6 x Amp$_{BSISO2}$)/2



Strategy

'15 '16



Forecast skill assessment

Data and Verification metrics

Period : 2013 ~ 2015
Season : MJJASO
Lead : WEEK1, WEEK2

	ECM	BOM	CFS	GFS	CWB
# of sample	104	80	285	300	29

Multi-category forecasts : Brier Skill Score

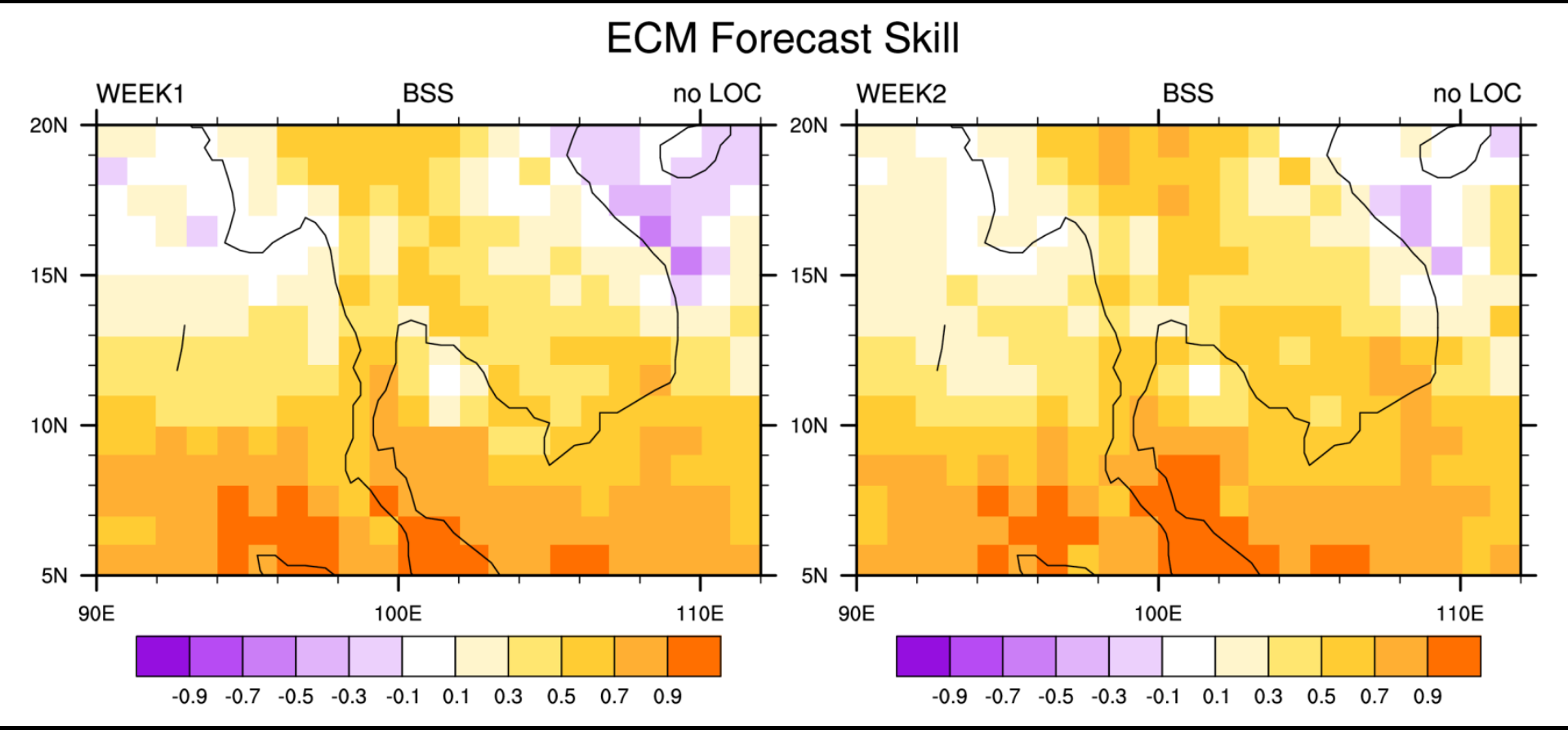
Contingency Table for multi-category forecasts

		Observed			
		1 PoHR <= 0.3 mm	2 0.3 < PoHR < THR	3 THR <= PoHR	Total
Forecast	1	n(F1,O1)	n(F1,O2)	n(F1,O3)	N(F1)
	2	n(F2,O1)	n(F2,O2)	n(F2,O3)	N(F2)
	3	n(F3,O1)	n(F3,O2)	n(F3,O3)	N(F3)
Total		N(O1)	N(O2)	N(O3)	N

From the Finnish Meteorological Institute (FMI)

Forecast skill assessment

Brier Skill Score of Heavy rainfall probability based on BSISO



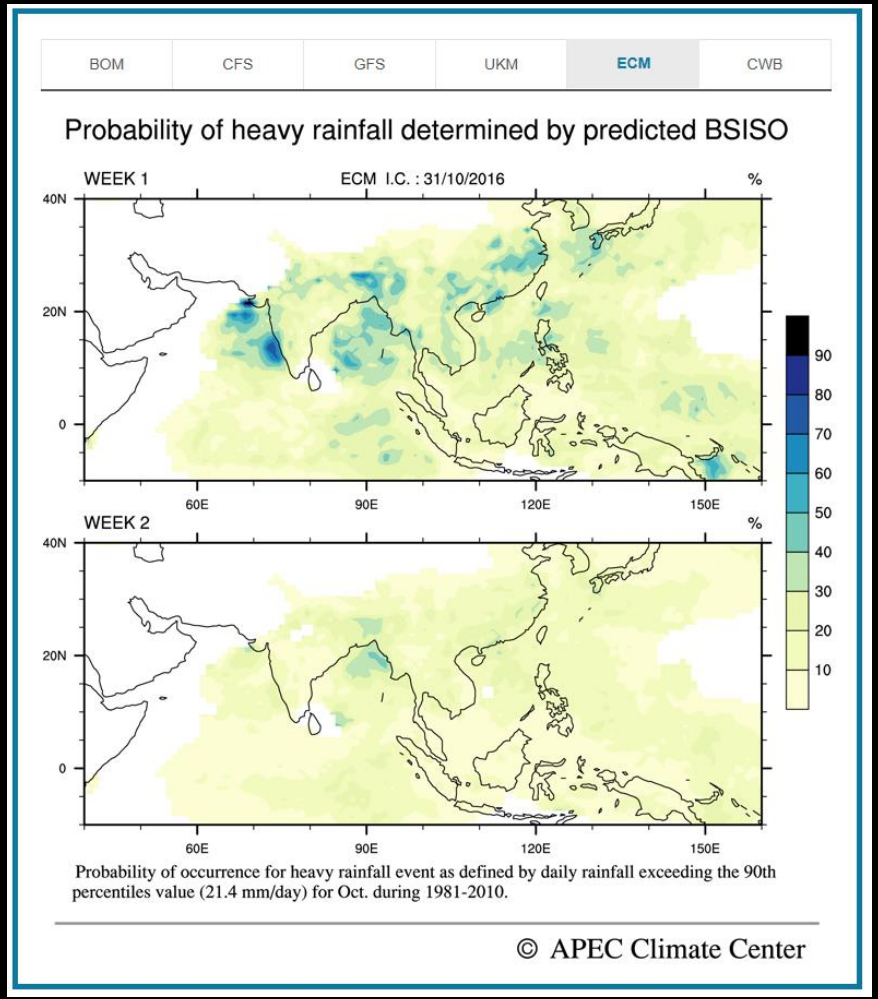
Probability forecasts of heavy rainfall in Mekong river basin show i***mprovements over 30-50%*** relative to climatological forecast at the lead time of WEEK2.

Delivery of user friendly forecast information

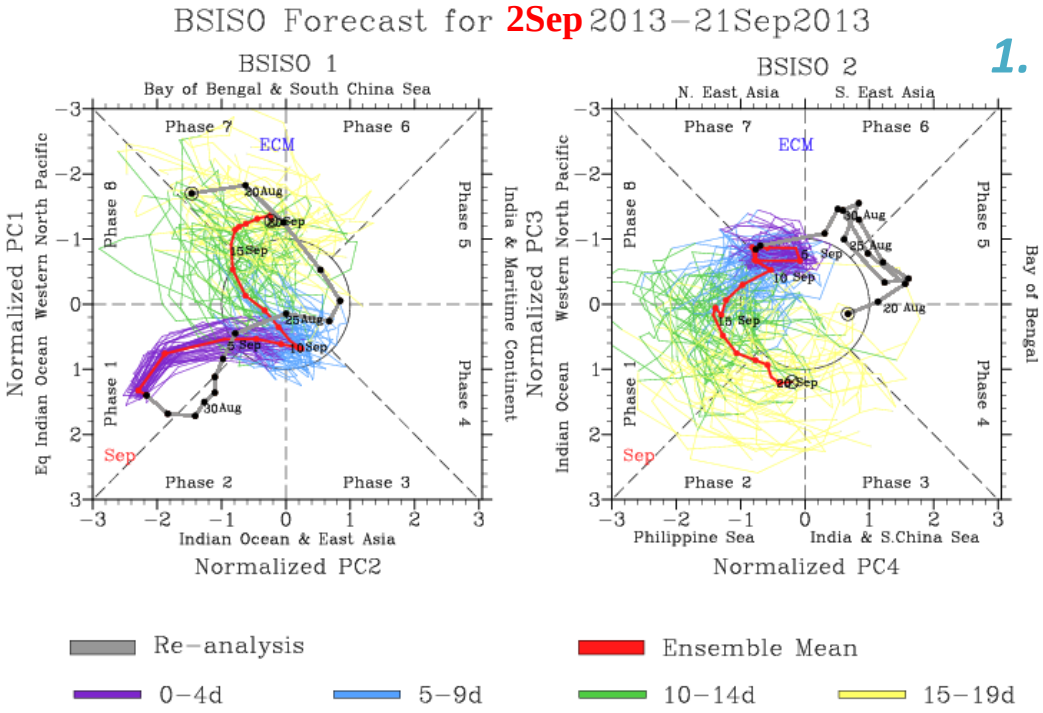
On the APCC webpage
For upcoming week1 and week2
Everyday updated

BSISO phase diagram may be difficult information for ordinary people.

So it is meaningful that simple index can be transformed into **user friendly information** such as rainfall.



Guideline

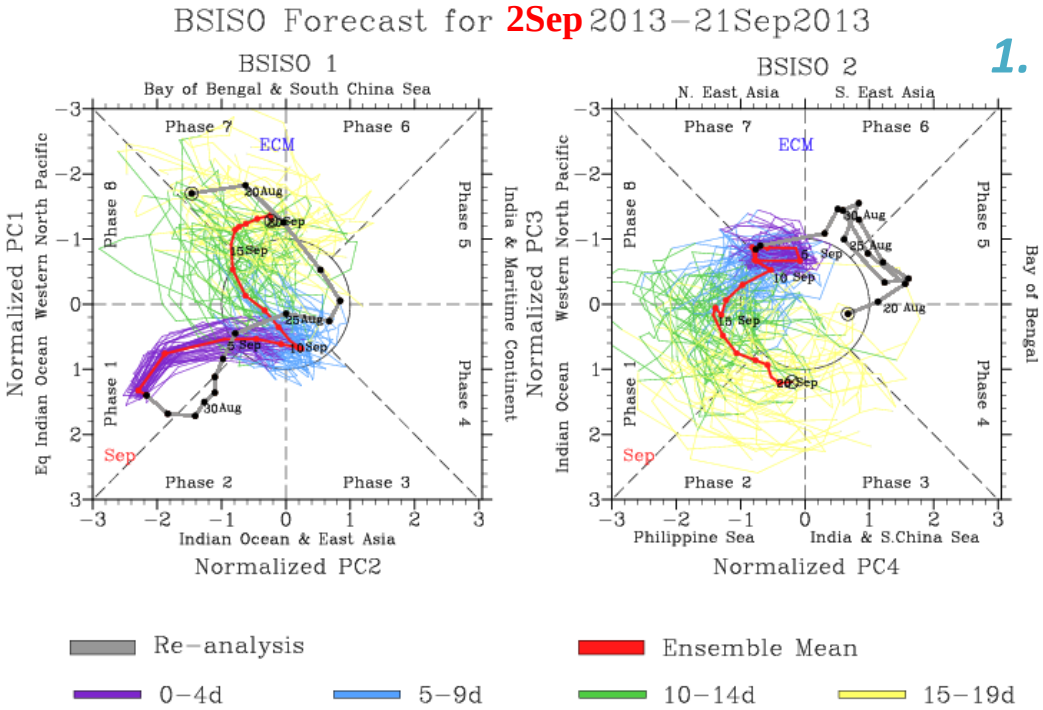


1. *Confirm the forecast of **BSISO phase** and **amplitude** for next two weeks*

→ *15-20Sep2013*

B1P7-8 , B2P1-2

Guideline



1. *Confirm the forecast of **BSISO phase** and **amplitude** for next two weeks*

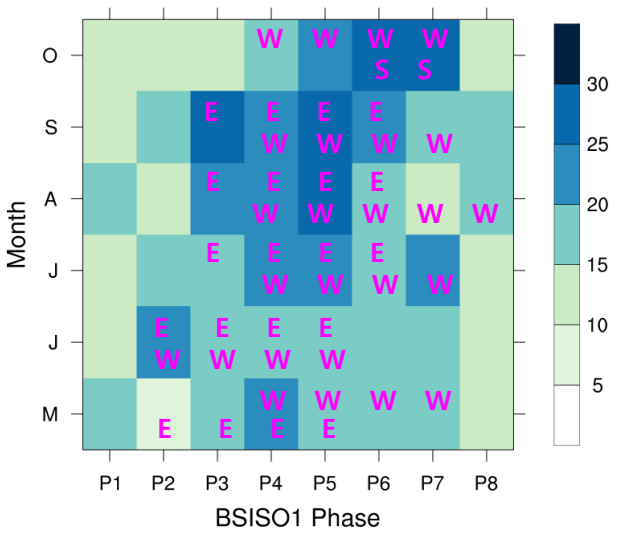
→ *15-20Sep2013*

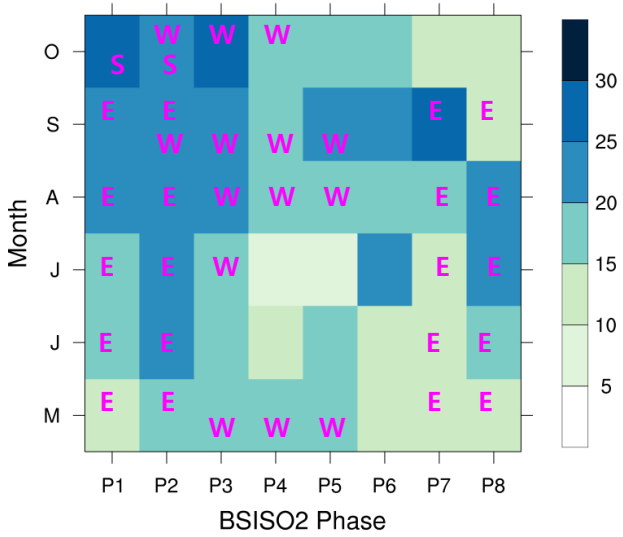
B1P8-7 , B2P1-2

2. *Find the **relationship** btw BSISO phase and heavy rainfall probability in the user guide.*

→ *B1P8-7 (Sep) W ~20%*

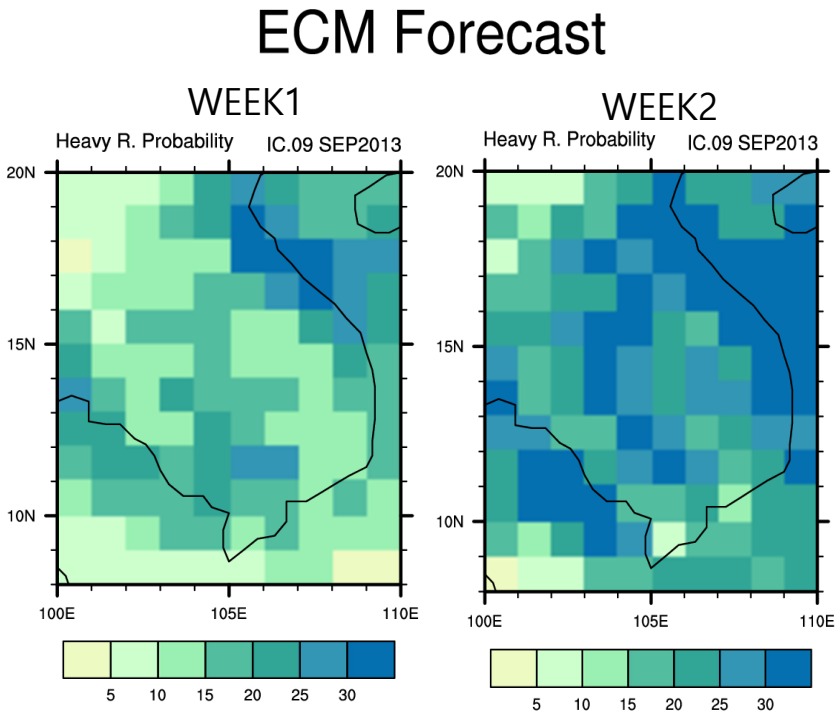
B2P1-2 (Sep) E,W ~25%

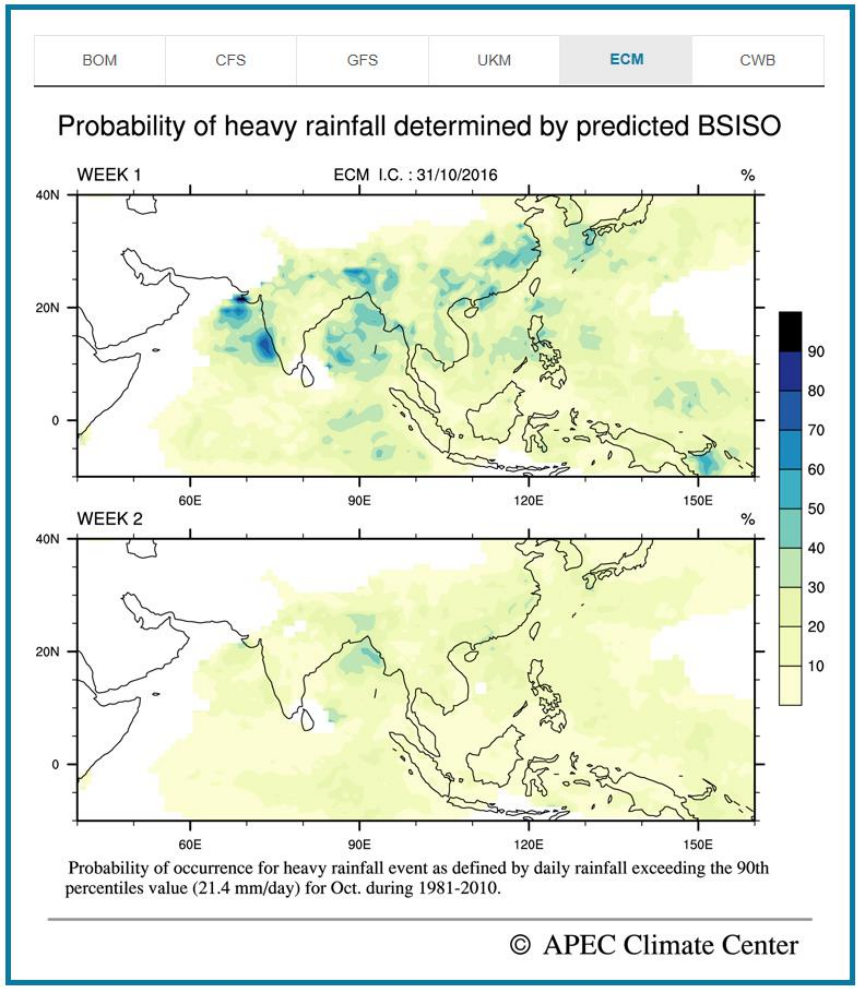




Guideline

3. For easier viewing,
you can go to ***heavy rainfall probability forecast map*** *in the APCC website.*

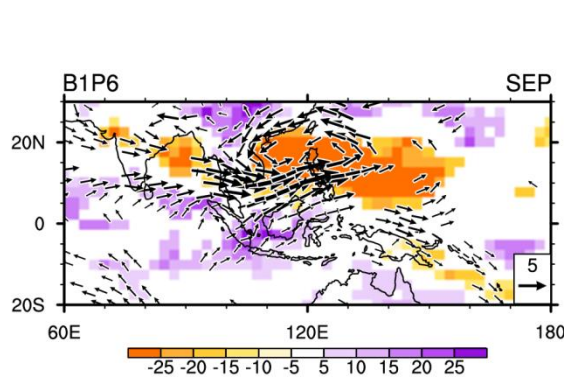


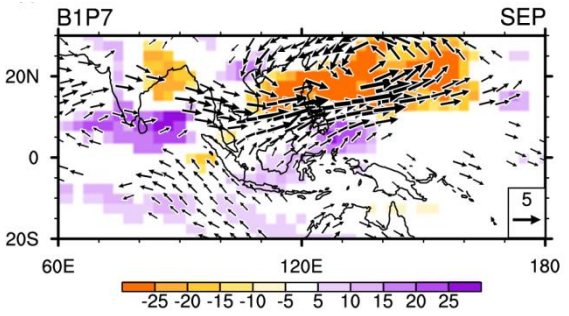


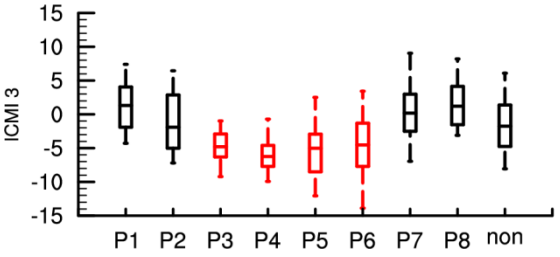
Guideline

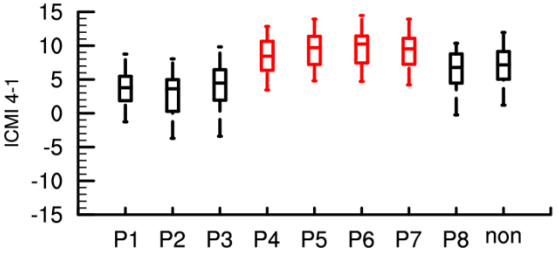
4. If you want to know the cause of easterlies and circulation pattern ..
*Look up it in the **mechanism** chapter or Appendix.*

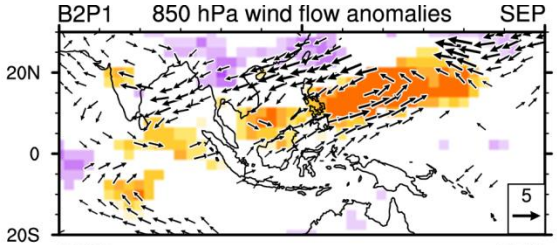
→ *Indo-china peninsular has favorable condition for having easterly (wes terly) wind due to a strong convective cell (anticyclonic cir.) located on the Philippine sea and the northwest Pacific (the Indian Ocean).*

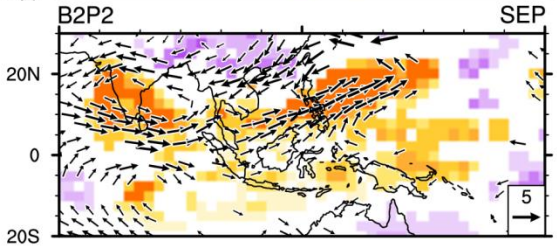


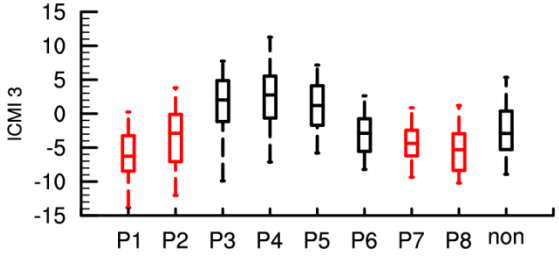








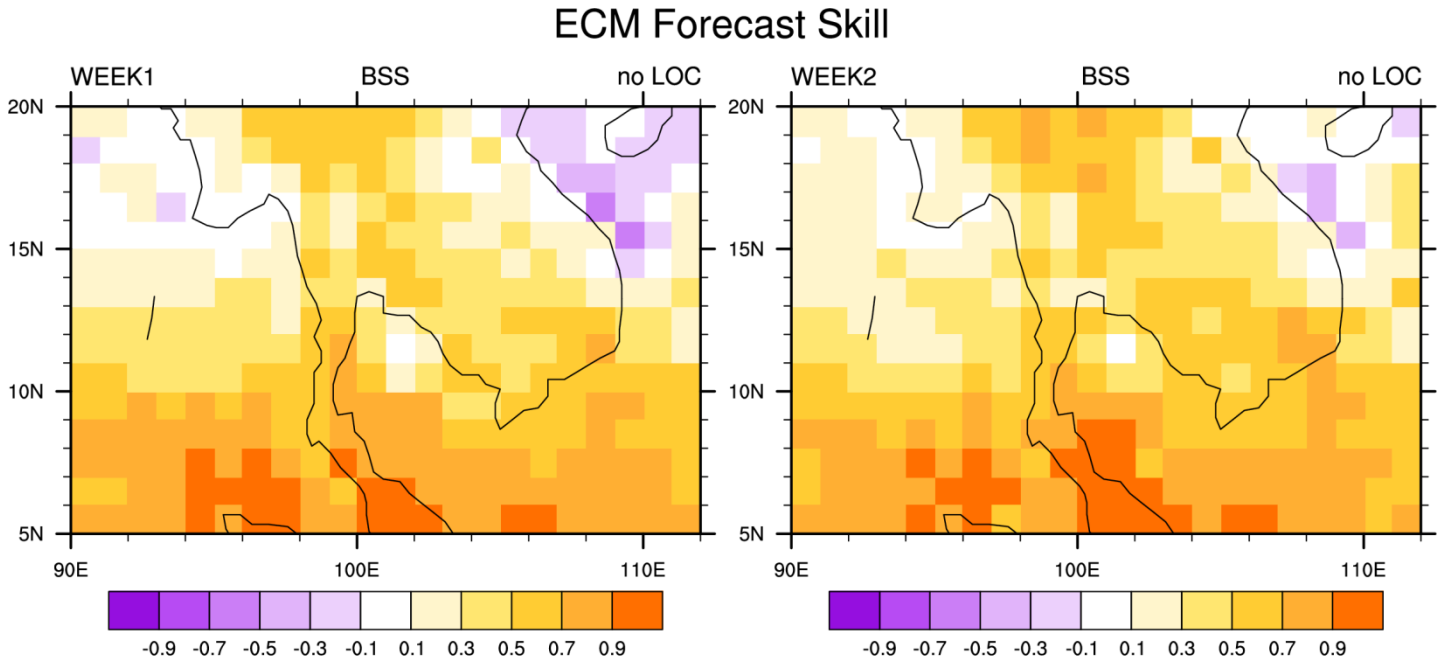




Guideline

5. There are some points to be duly considered.

→ *Probability forecasts of heavy rainfall at 1-week and 2-week lead show improvements of 30% - 50% relative to climatological forecasts over the Mekong river.*



Summary

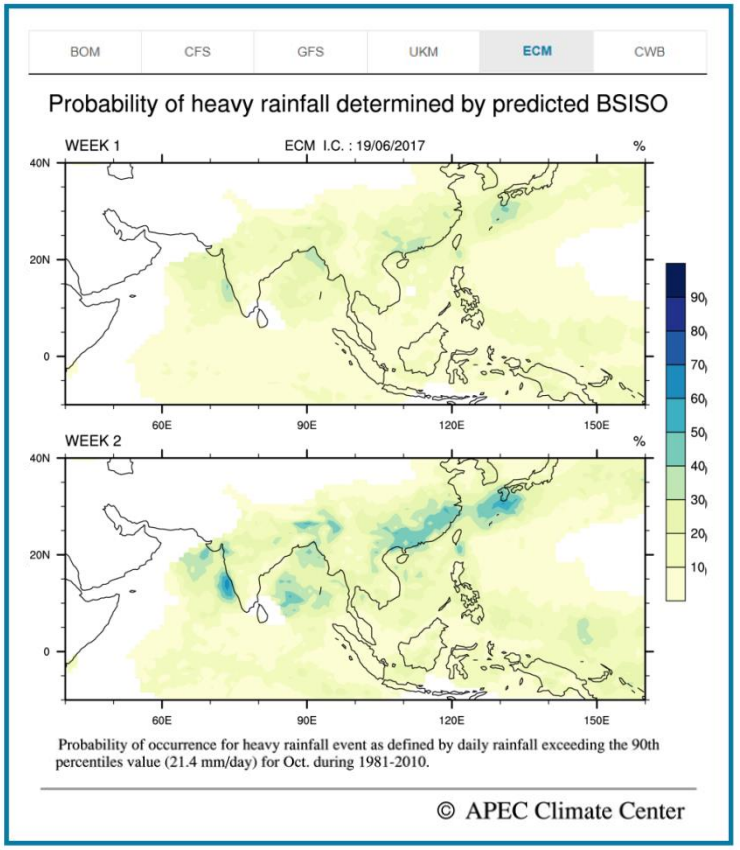
Multi Model Subseasonal (BSISO) forecast

: better forecast from better recognition of the value

Development of a guideline to increase practical use of BSISO forecast

Heavy rainfall forecast
based on BSISO index forecast [ECMWF]

- **Ex> Japan flood, 398mm/4hr, July 6, 2017**



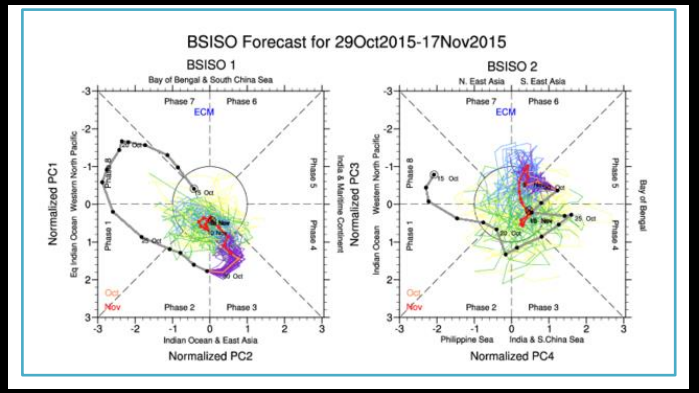
Summary

Multi Model Subseasonal (BSISO) forecast

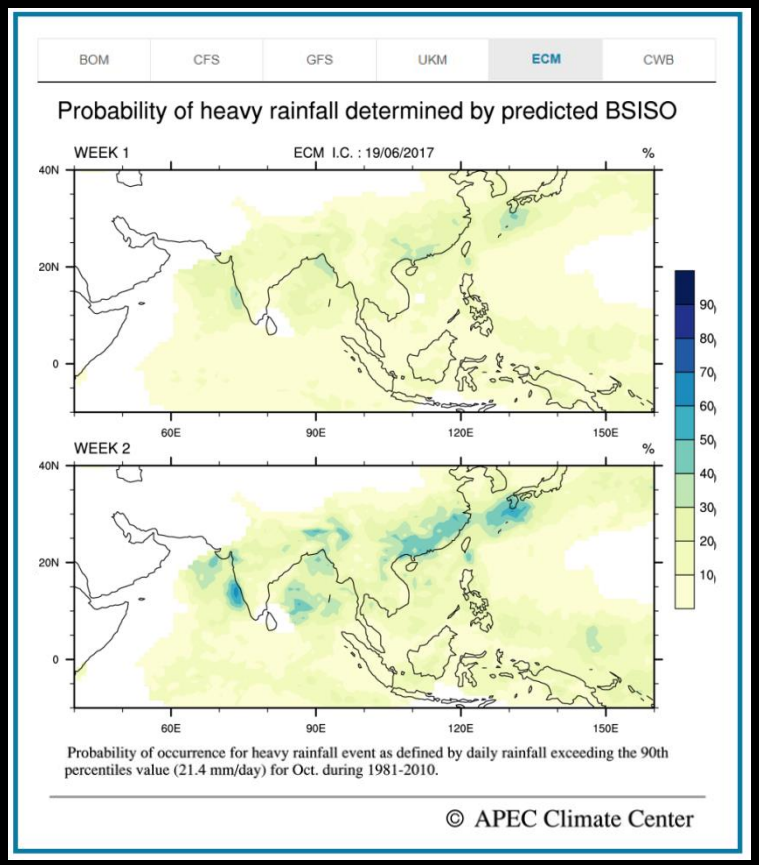
: better forecast from better recognition of the value

Development of a guideline to increase practical use of BSISO forecast

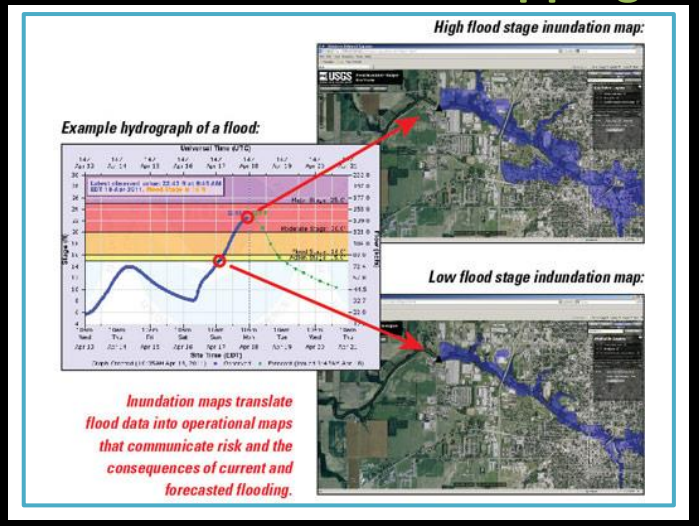
BSISO forecasts



Heavy rainfall forecast



Flood Inundation Mapping




Thank you

[110] Impact of Boreal Summer Intraseasonal Oscillation on Changma Precipitation over South Korea

Yoo-Rim Jung (yrjung@apcc21.org) and Hae-jeong Kim

Climate Research Team, Climate Prediction Department, APEC Climate Center, Busan, S. Korea

❖ South Korea belongs to the East Asian monsoon region, characterized with rainy seasons (referred to as the Changma period) in summer. In this study, how the Boreal Summer Intraseasonal Oscillation (BSISO) modulates the spatial distributions of rainfall occurrence during the Changma period over South Korea is investigated, using the BSISO indices proposed by Lee et al. (2013).

❖ BSISO indices were formed by the time series associated with the MV-EOF of combined OLR and 850-hPa zonal wind anomalies over the Asian summer monsoon region (10°S-40°N, 40°-160°E) from May to October. BSISO indices are divided into two indices- one is the BSISO1 index defined by the first and second EOF modes that represents the canonical northward propagating variability with the periods of 30-60 days, while the other one is the BSISO2 index defined by the third and fourth EOF modes which represents the northward/northwestward propagating variability with the periods of 10-20 days.

❖ To investigate the BSISO's evolutions and impacts on the South Korean rainfall with composite analysis, the life cycles of BSISO1 and BSISO2 were divided into strong eight phases, denoted as phase 1 to phase 8 by using BSISO1 and BSISO2 indices, respectively. The analysis period for precipitation (the other variables) covers the period from 1981 to 2007(2015) during the Changma period defined as 6/23-7/25.

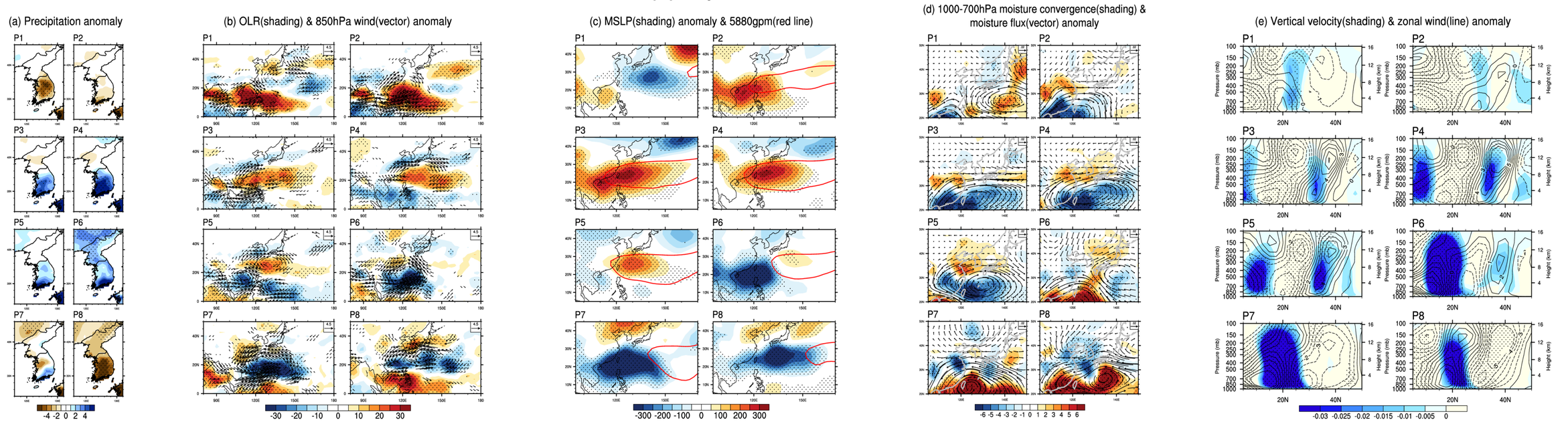
❖ The strong BSISO1 event can be defined when the normalized amplitude $[(PC1^2+PC2^2)^{1/2}]$ of the BSISO1 index is greater than 1.0, and the same approach is used to define the strong BSISO2 event.

❖ To produce the intraseasonal anomaly time series daily anomalies of rainfall and other variables were computed by removing the slow annual variation (mean and first three harmonics of climatological annual cycle) and the effect of interannual variability by subtracting a running mean of the last 120 days.

Possible linkages of BSISO to Changma precipitation and BSISO-related large-scale conditions

❖ Climatologically, warm and moist air is transported from the ocean by the southwesterly flow along the northwestern edge of the Western North Pacific Subtropical High(WNPSH), and the upper-level westerly jet is located above the Korean Peninsula. South Korea then enters its main rainy season, the so-called Changma, and continues for a month from late June until late July. Deep convective systems associated with stationary fronts can cause heavy rainfall during Changma. During the Changma period, the BSISO activity led to a change in regional patterns of precipitation over South Korea.

(1) Impact of BSISO1 mode



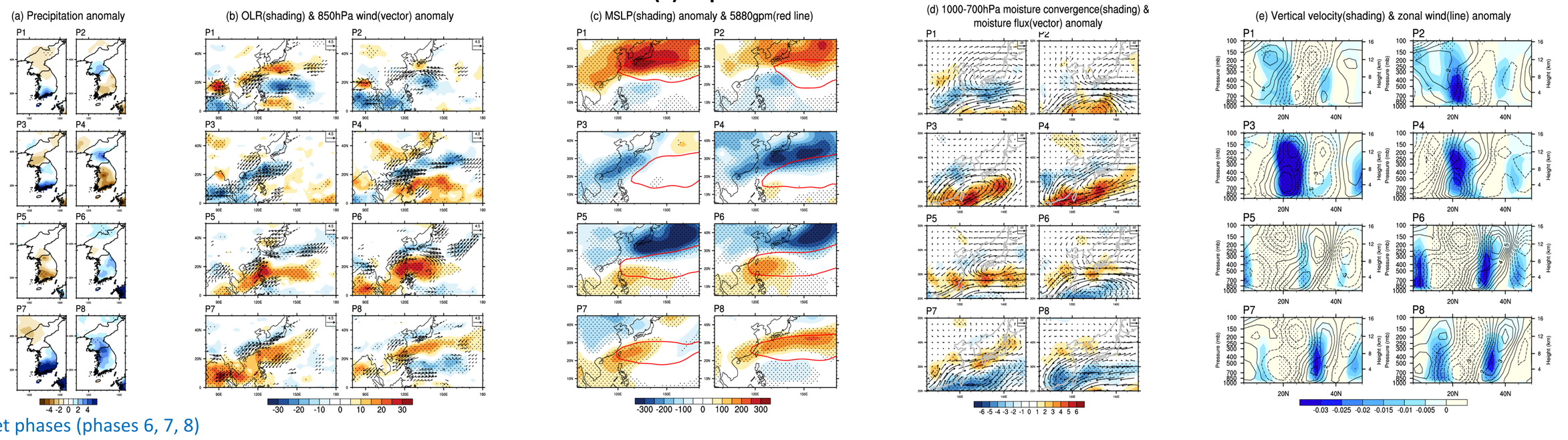
❖ Wet phases (phases 3, 4, 5)

Anomalous southwesterly winds in low-level transported more moisture into South Korea(positive shading is moisture convergence anomaly as shown in Fig. (d)), leading to positive rainfall anomalies as the anticyclonic circulation was strengthened in the northwest Pacific (the 5880-m geopotential isoline indicates the center of WNPSH as shown in Fig. (c)). Also, a clear ascending anomaly existed within the latitude band from 30°N to 35°N, and in the region to north of ascending branch, westerly anomalies prevailed in the upper level.

❖ Dry phases (phases 8, 1)

The WNPSH retreated eastward and weakened, and South Korea was dominated by the northeasterly anomaly which was unfavorable for moisture transportation to inland, and thus precipitation over South Korea was suppressed. In addition, the weakening of the ascending motion that initiated active convection over South Korea and the upper-level westerly jet may provide a dynamical support for dry phases.

(2) Impact of BSISO2 mode



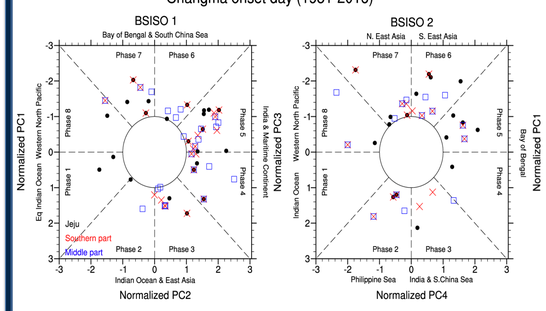
❖ Wet phases (phases 6, 7, 8)

With the further northward propagation of the anomalous anticyclonic circulation, its southwesterly anomalies began to influence South Korea, transporting large amounts of moisture to inland along the edge of stronger the WNP subtropical high. As the ascending anomalies were moved toward north, the enhanced westerly jet also experienced an northward movement in the upper level.

❖ Dry phases (phases 4, 5)

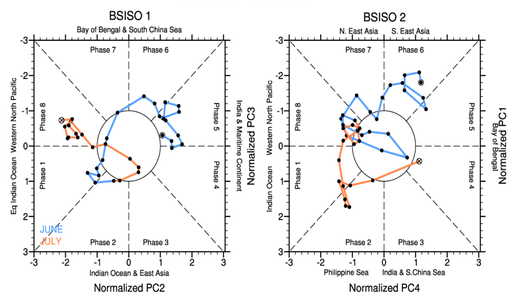
Relatively weak convection anomalies existed in South Korea, resulting from anomalous northeasterlies on the northwestern side of the anomalous cyclonic circulation. A southward migration of the center of the WNPSH caused the weakening of the low-level moisture flux convergence toward inland. The descending anomaly and weakened upper-level jet were attributed to suppressed rainfall.

Changma onset day (1981-2016)



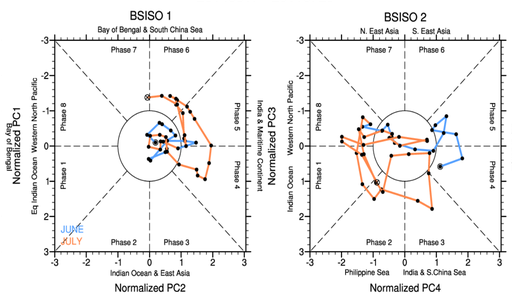
2011 Changma (Wet year)

20110610 - 20110717



2014 Changma (Dry year)

20140617 - 20110729

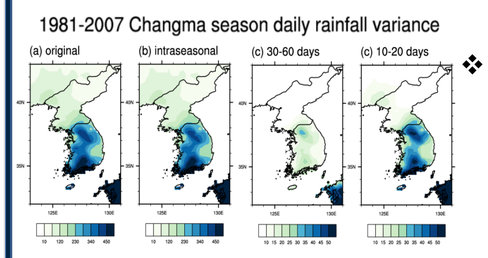


❖ The Changma onset events occurred when the BSISO1(BSISO2) was active during wet phase5(phase6) from 1981 to 2016.

❖ In 2011, as the WNPSH extended northward, the Changma started earlier than normal, and the average rainfall during the Changma period was 589.5 mm which was the second largest amount since 1973(KMA, 2011). It was obvious that strong BSISO1(BSISO2) mode started from wet phases5-6(phases6-8).

❖ The 2014 Changma has seen less rainfall than usual because the WNPSH was so weak that the Changma front could not move north and stayed near Jeju island(KMA, 2014). In the beginning of the Changma season, the BSISO1 mode was weak, and the BSISO2 mode showed the dry phases4-5.

Which of BSISO1 and BSISO2 contributes large variations in the daily rainfall in South Korea during Changma period ?



❖ The intraseasonal component of rainfall may describe part of total component of rainfall, and the major variances in rainfall in South Korea come from the BSISO2 mode during the Changma period.

Summary and Comments

❖ The present results suggest that the BSISO is one of the important factors for the variation of rainfall during the Changma period and the Changma onset day in South Korea. As the characteristics of the Changma have changed in recent years, further study on the relations with BSISO is needed.

Lee, J. Y., B. Wang, M. C. Wheeler, X. Fu, D. E. Waliser and I. S. Kang, 2013: Real-time multivariate indices for the boreal summer intraseasonal oscillation over the Asian summer monsoon region. Climate Dyn., 40, 493–509.