Enhancing the practical usefulness of APCC's BSISO information

(Mar. 21, 2018)

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Better forecast? *practical use*

Reliable forecast

Reasonable interpretation

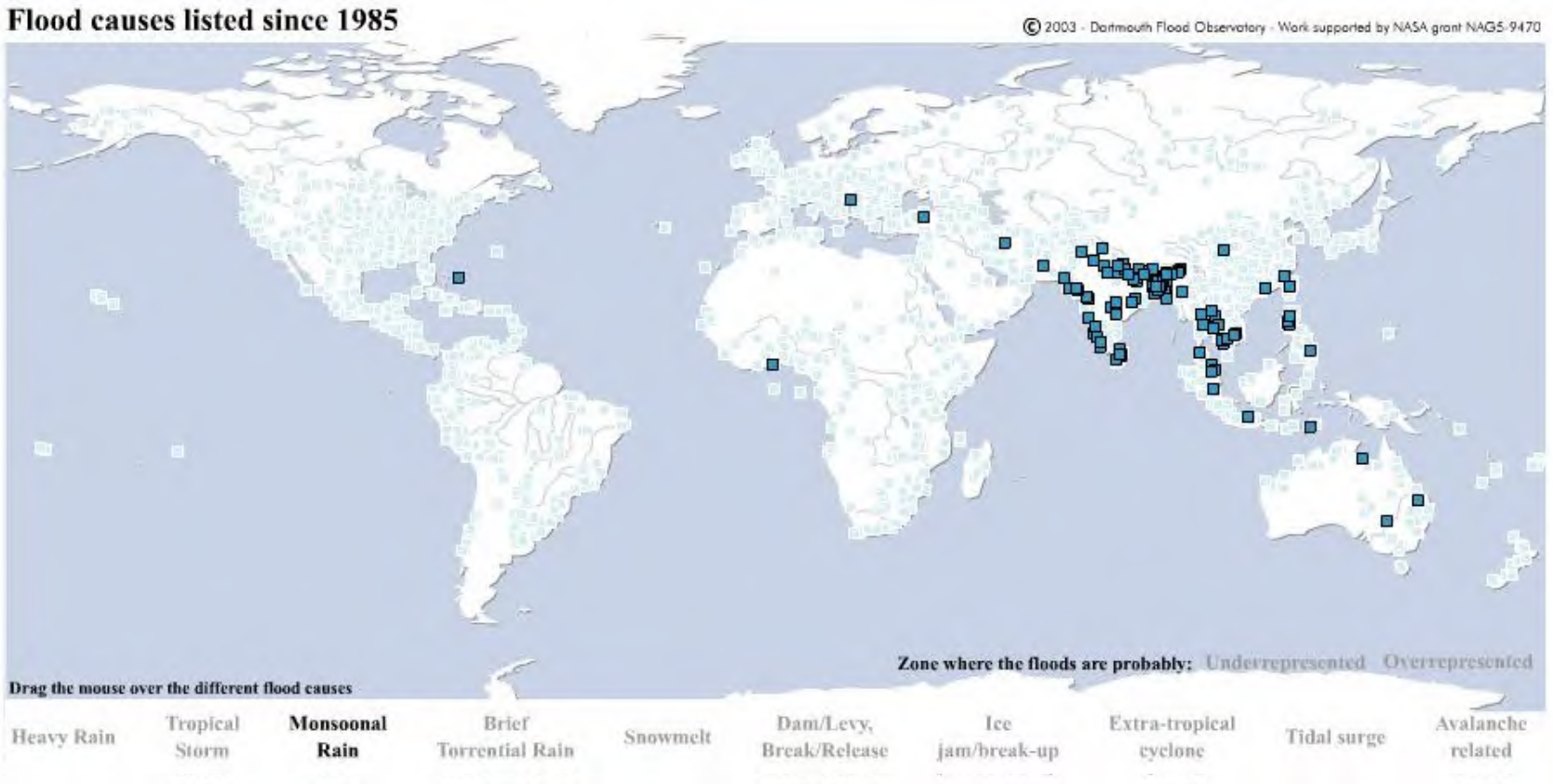
Recognition of the value

Actionable information

Illegible BSISO index
→ user friendly information

Better forecast? *practical use*

What is the actionable information for?



A lot of ***flooding*** is caused by heavy rain, tropical storm and monsoonal rain .

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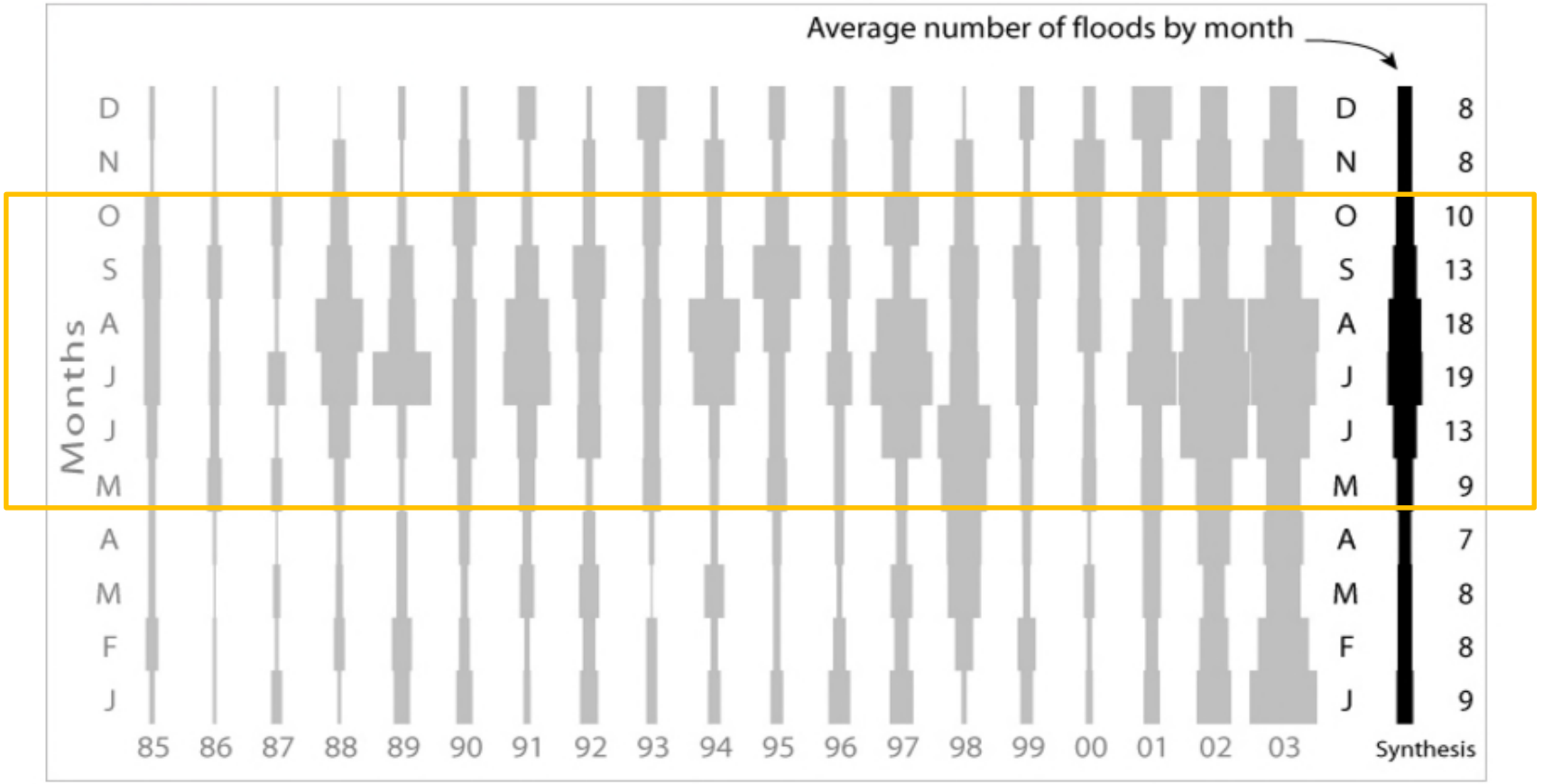
What is the actionable information for?

When do the floods start?



Those could be ***considerably associated with the BSISO activity.***

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Under operational perspective

#1. To find the BSISO impact on heavy rainfall

#2. To make a user guideline for somewhere or somebody

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

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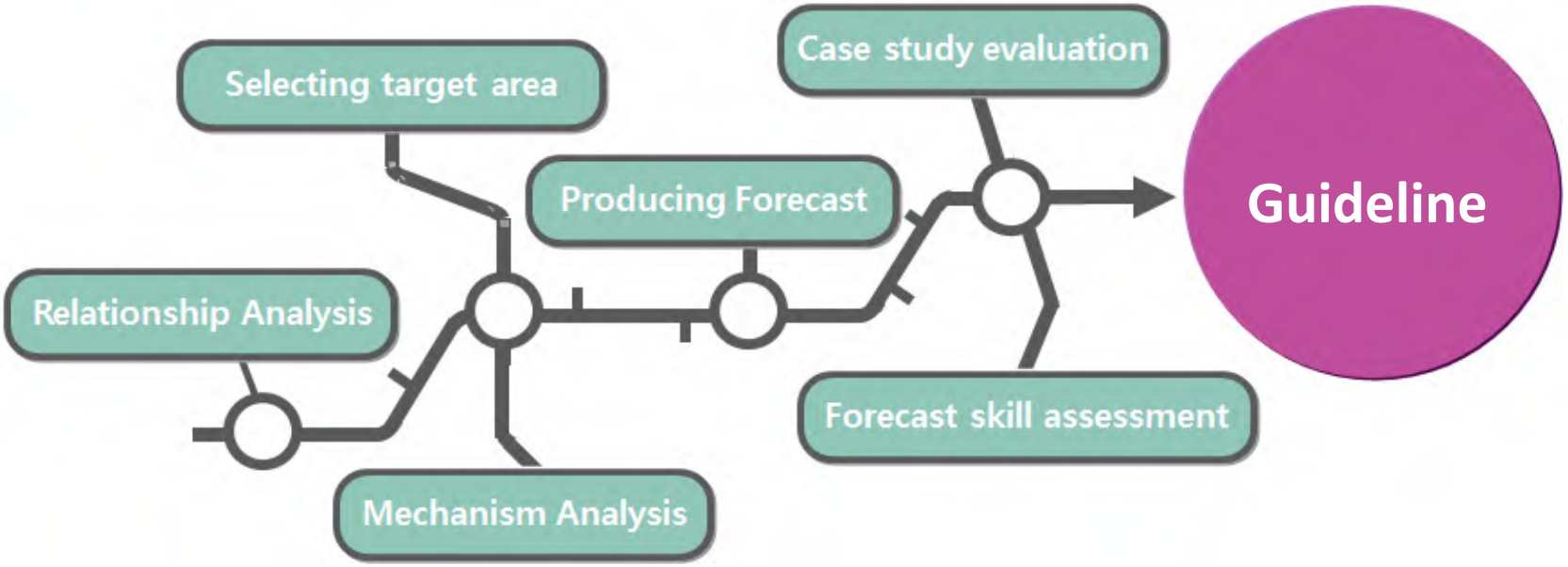
Strategy

'15 '16



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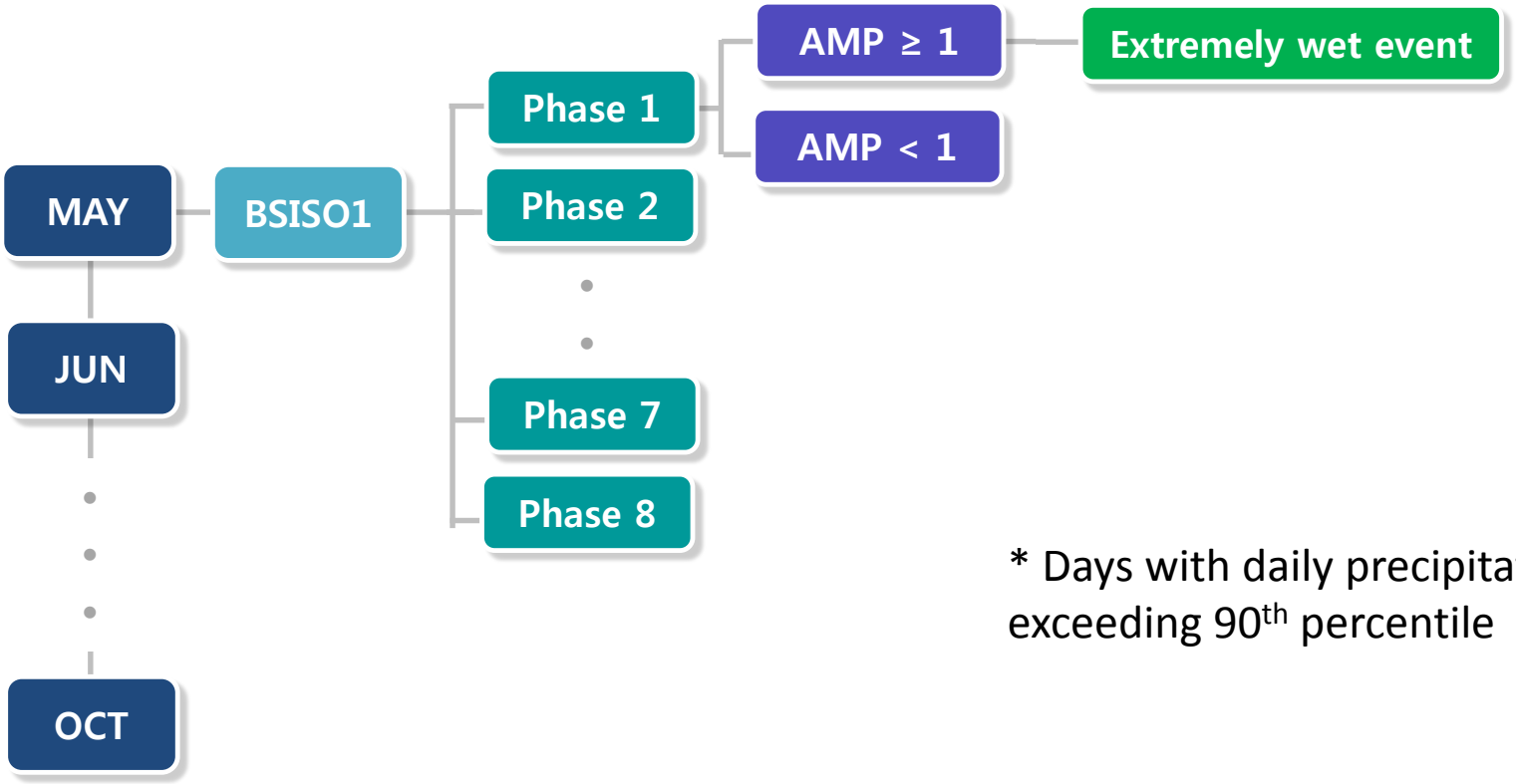
Relationship analysis ***(Composite analysis : BSISO-Heavy rainfall probability)***



* 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

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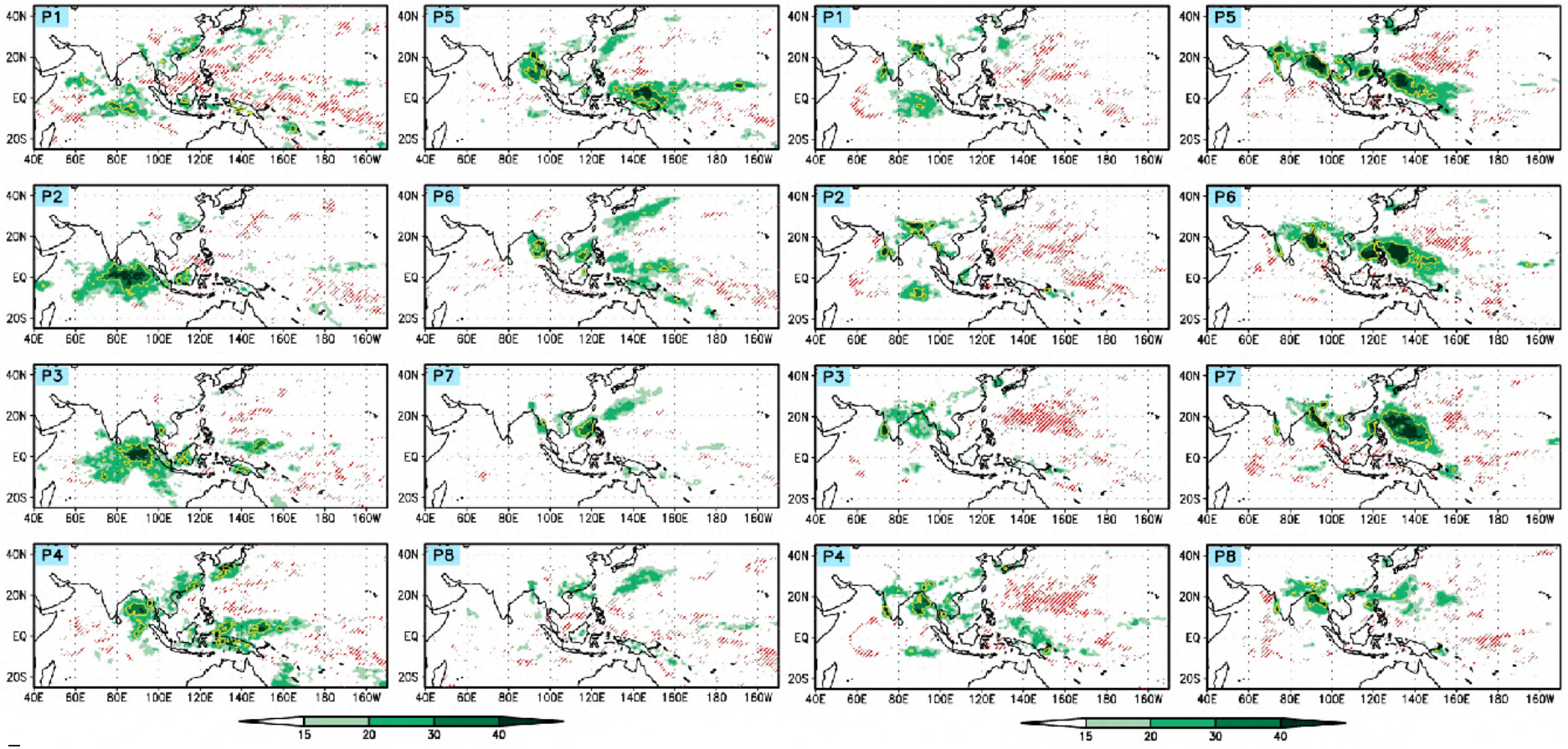
Relationship analysis ***(Composite analysis : BSISO-Heavy rainfall probability)***

Probability of extreme rainfall occurrence based on BSISO phases

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

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



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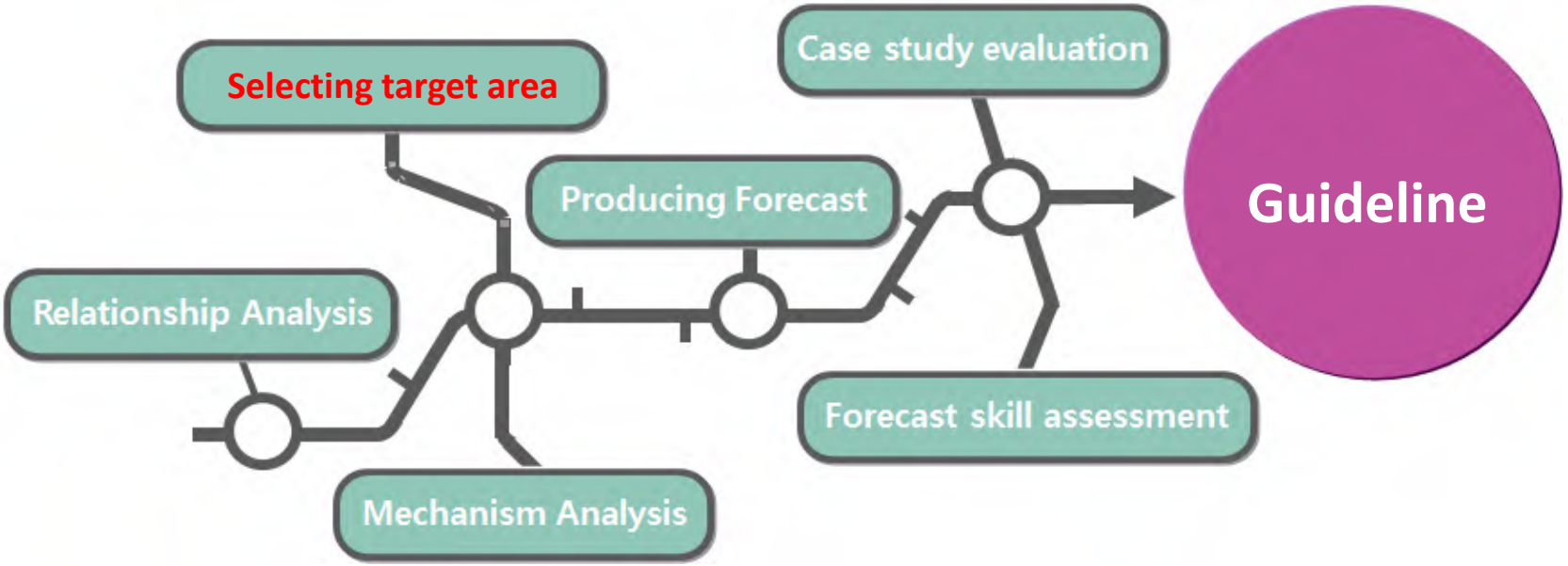

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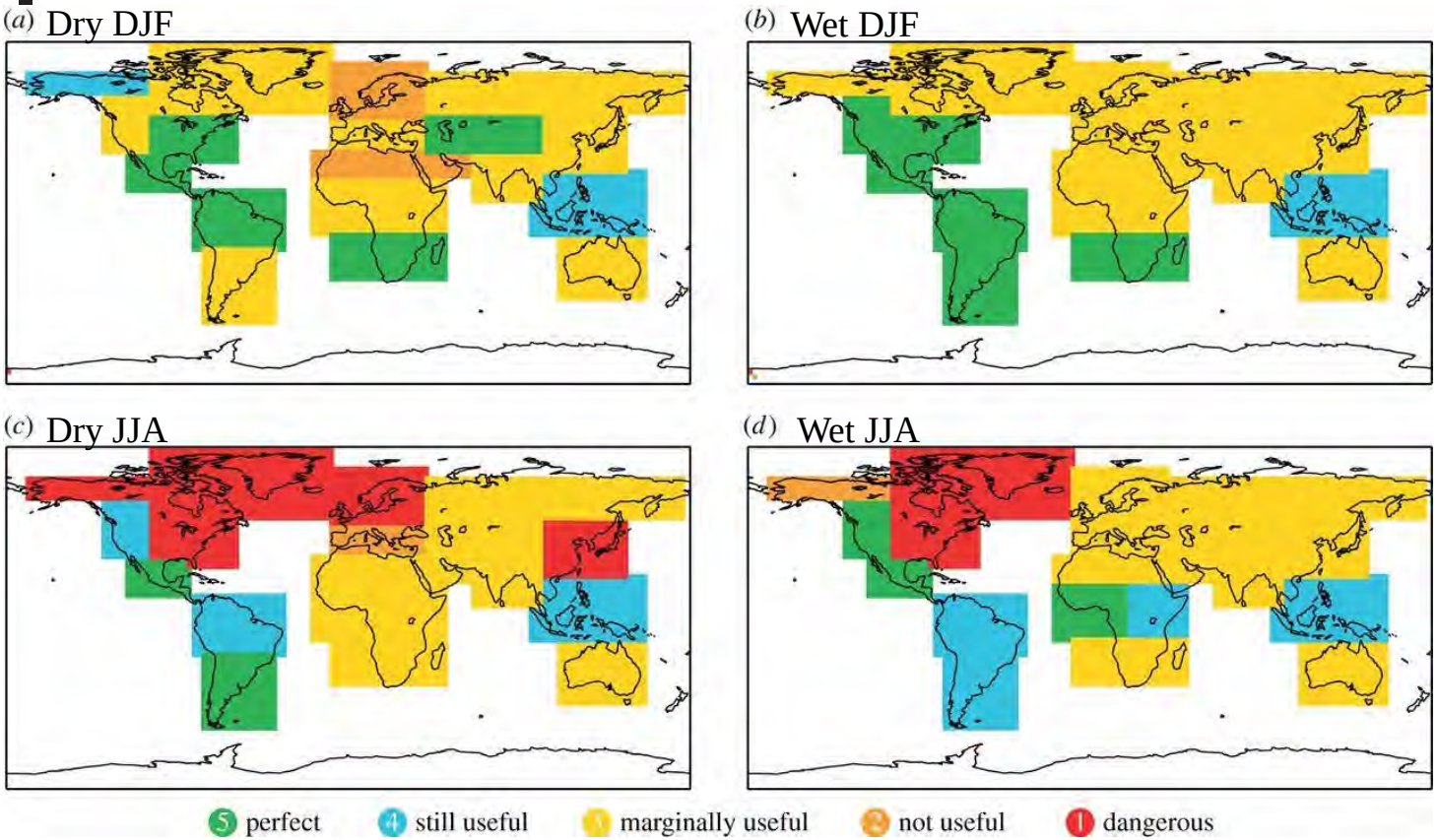
Selecting target area

#R1. Developing countries in the APEC region

#R2. Predictable region from the view of meteorologist

Reliability categorization of precipitation forecasts

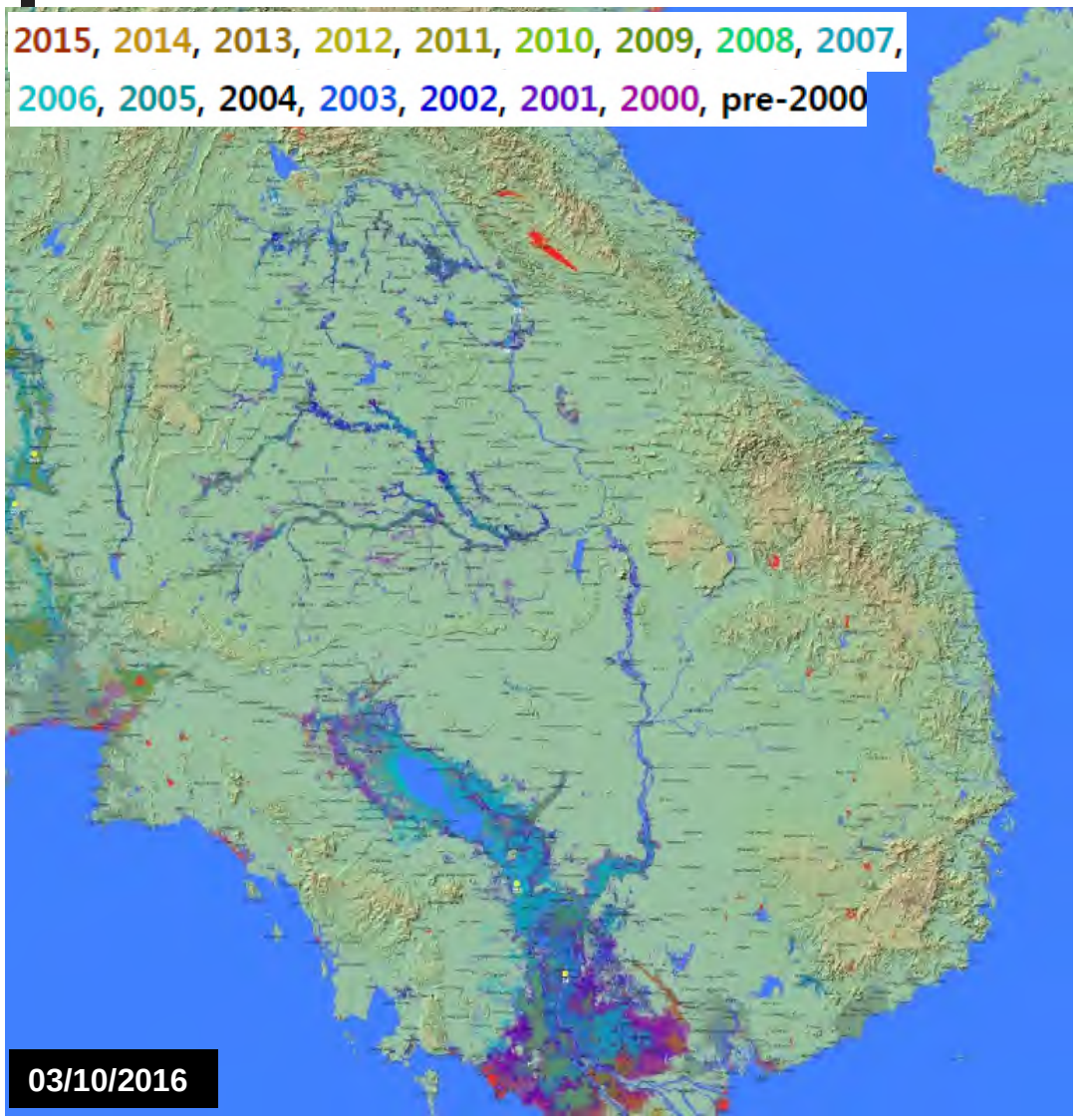


The precipitation forecast over ***Southeast Asia*** is useful.
It is consistent among the events and seasons.

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

Better forecast? *practical use*

Selecting target area



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

http://floodobservatory.colorado.edu

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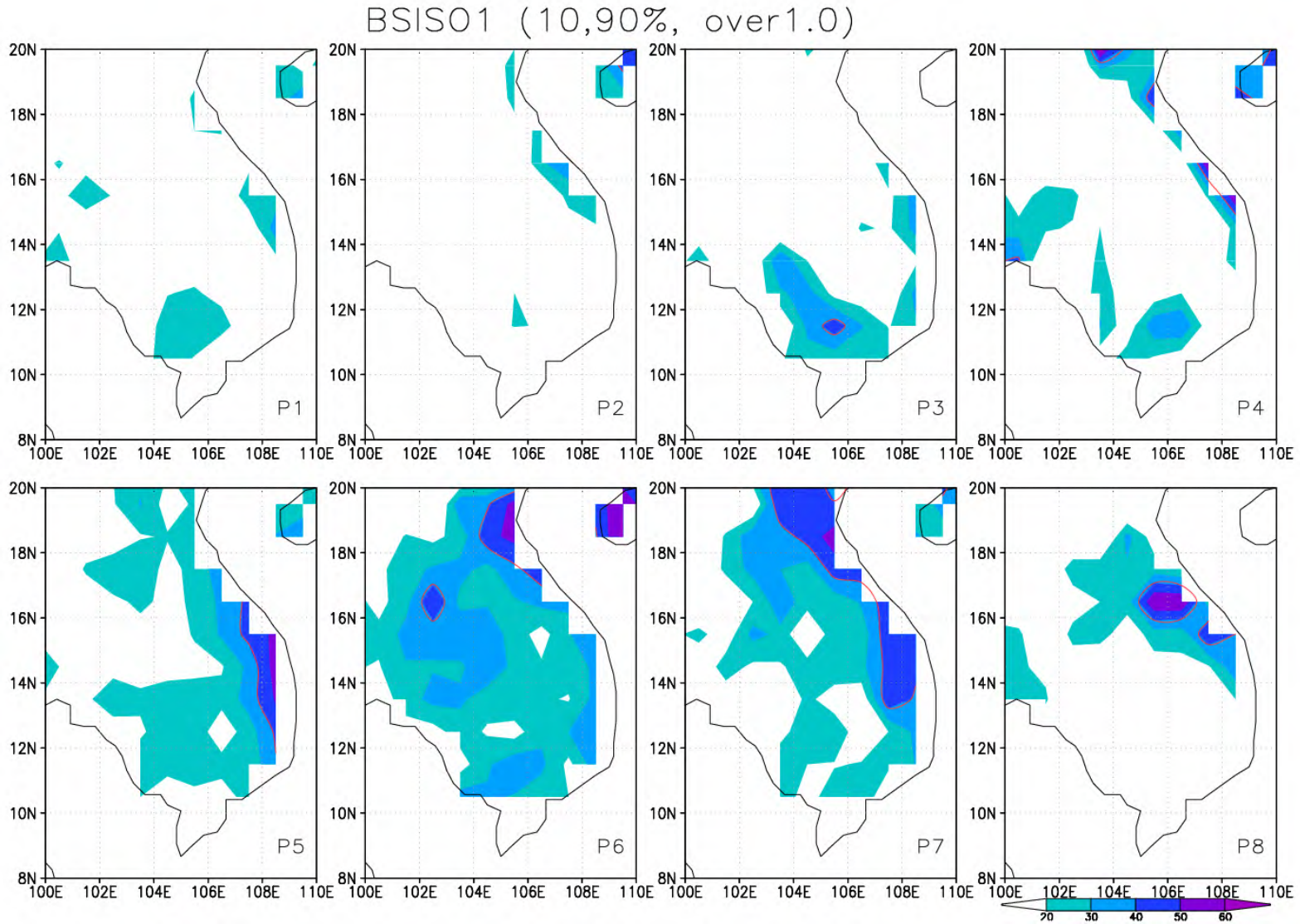

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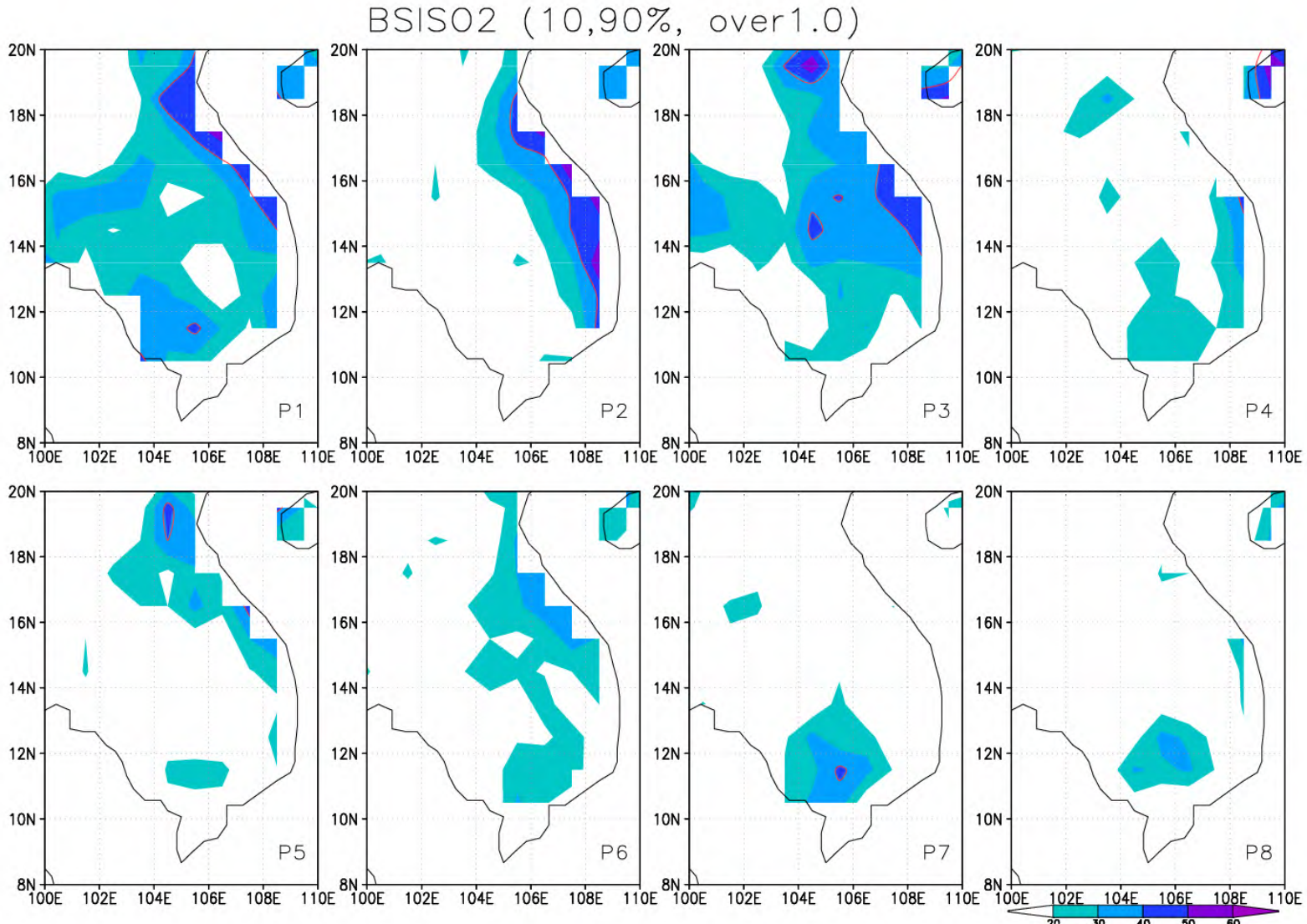

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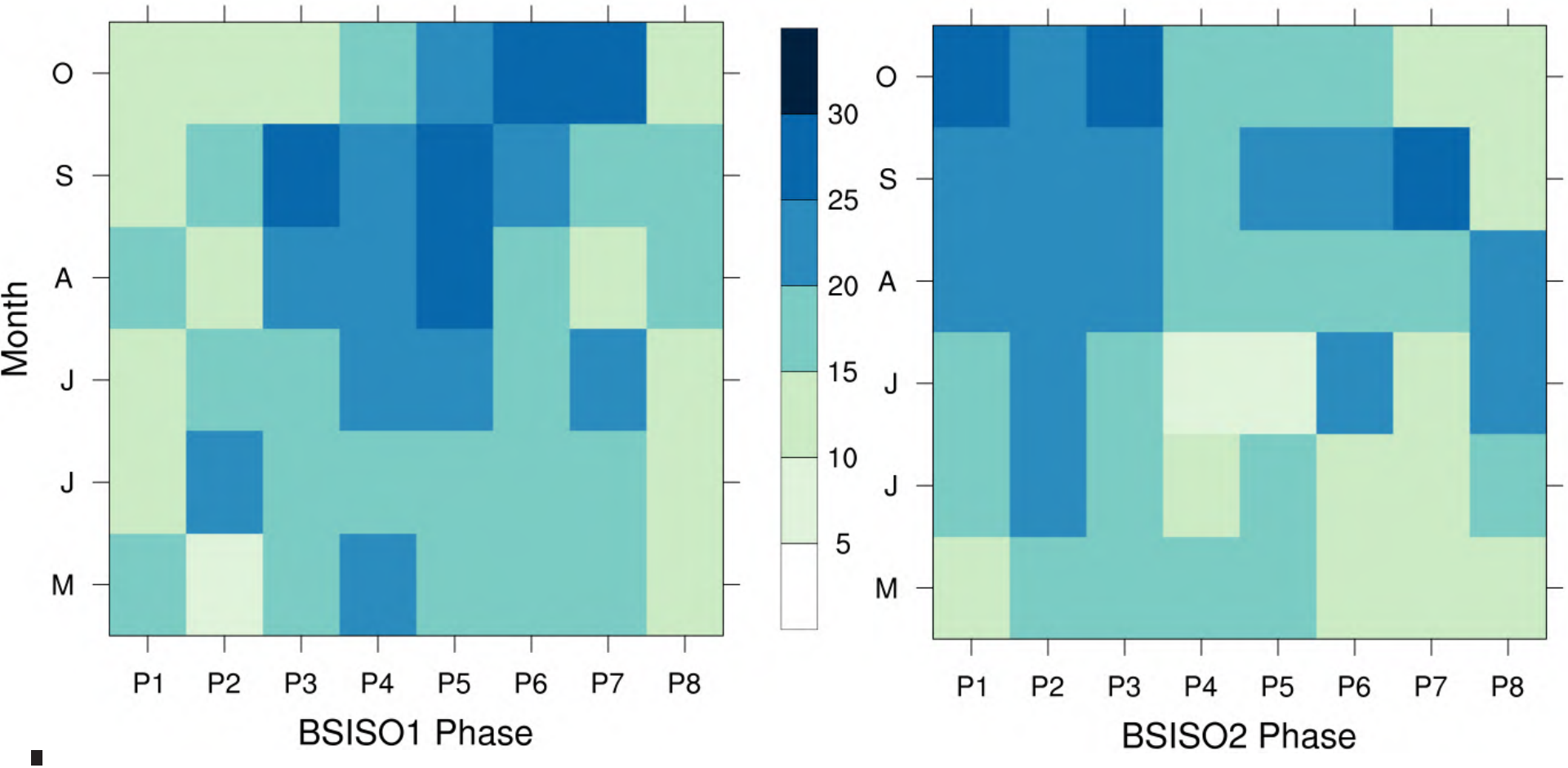
Relationship analysis ***(Composite analysis : BSISO-Heavy rainfall probability)***

Probability of Heavy Rainfall occurrence [Mekong River]



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Strategy

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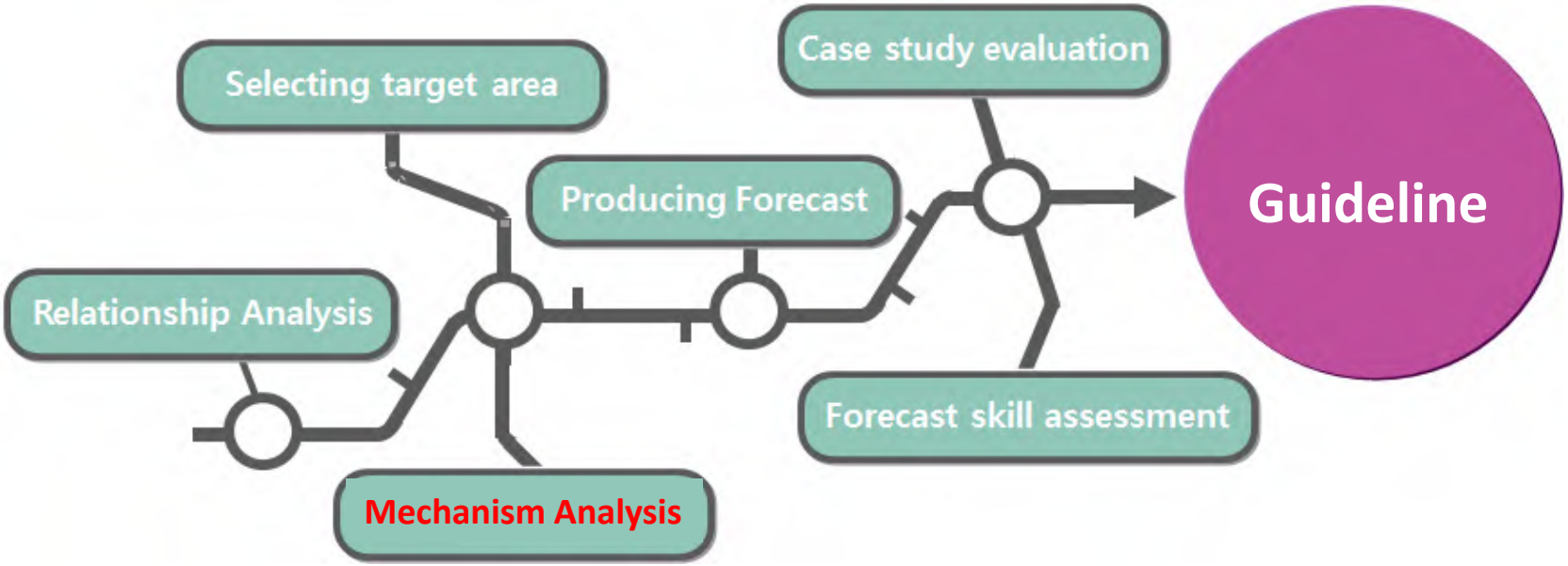
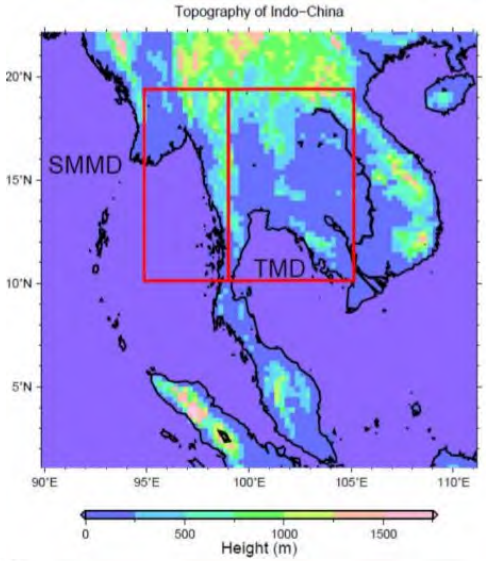


Better forecast? *practical use*

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.



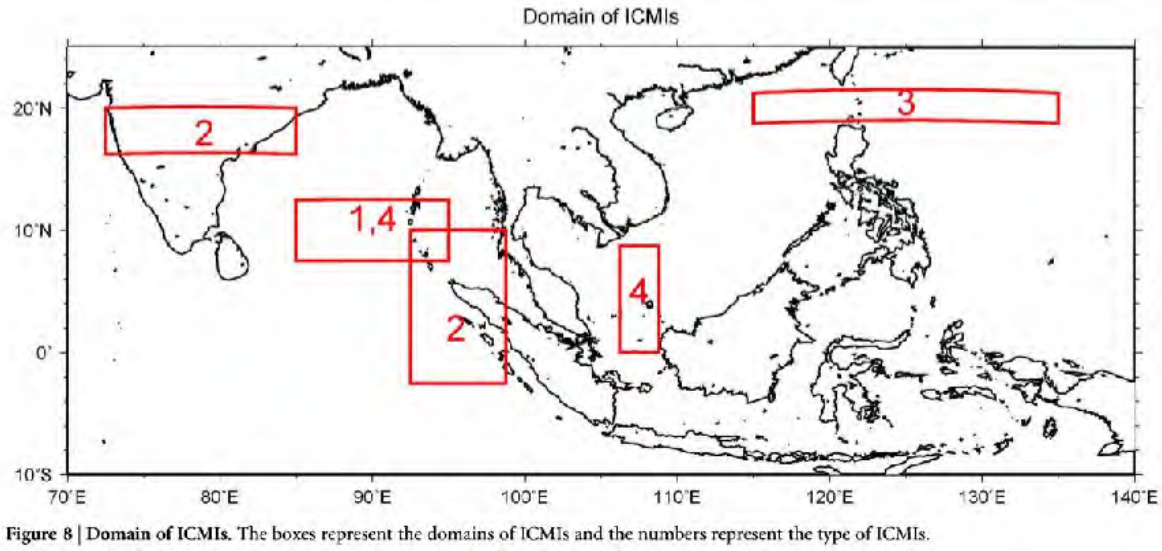


Figure 8 | Domain of ICMIs. The boxes represent the domains of ICMIs and the numbers represent the type of ICMIs.

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

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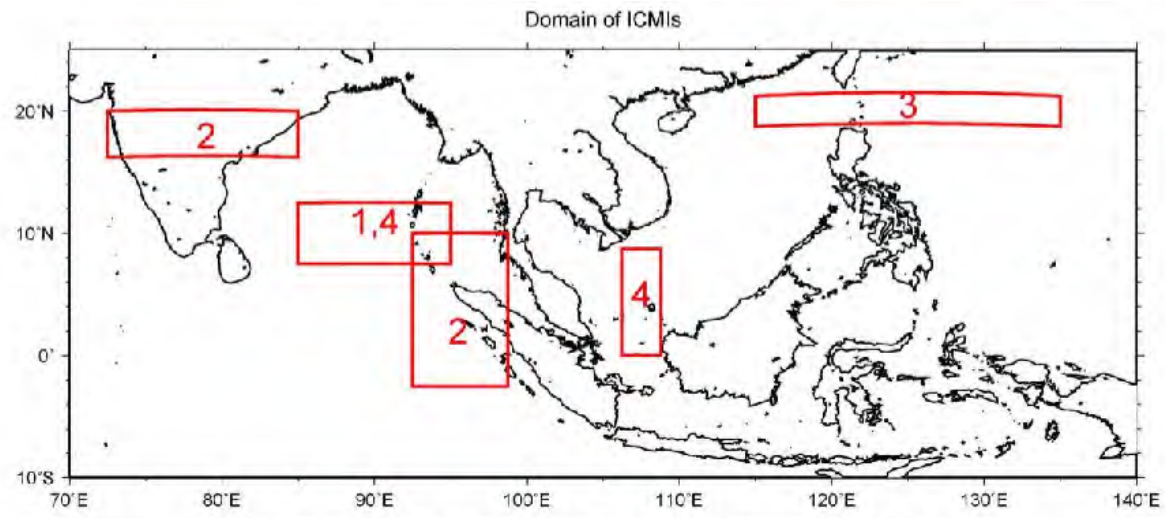
Mechanism Analysis ***(BSISO-Extreme rainfall probability)***

[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.



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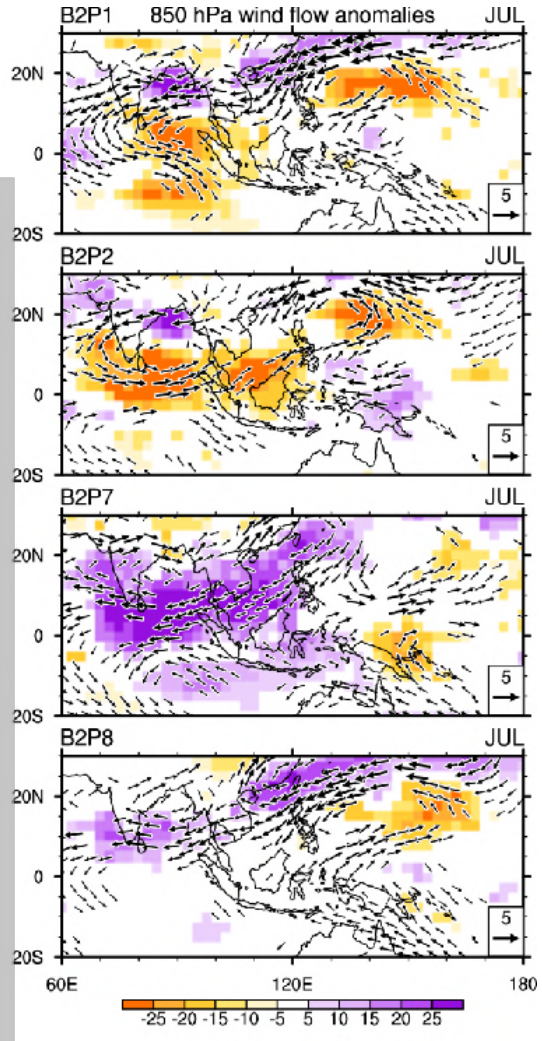
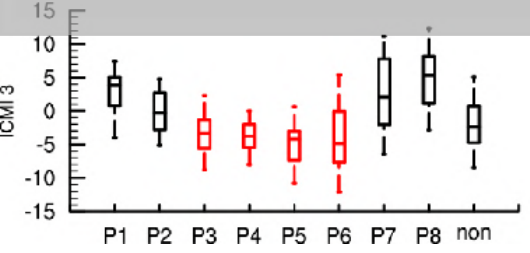
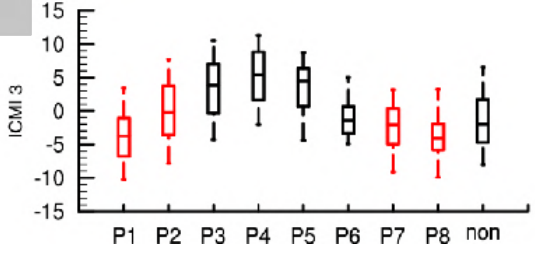
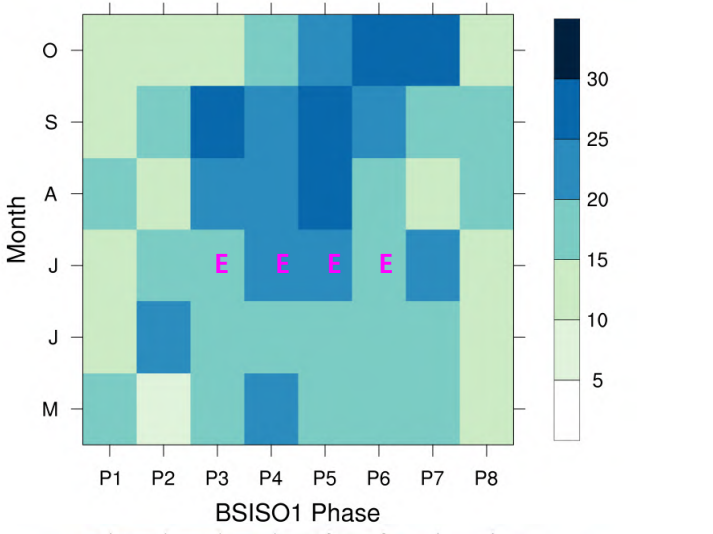
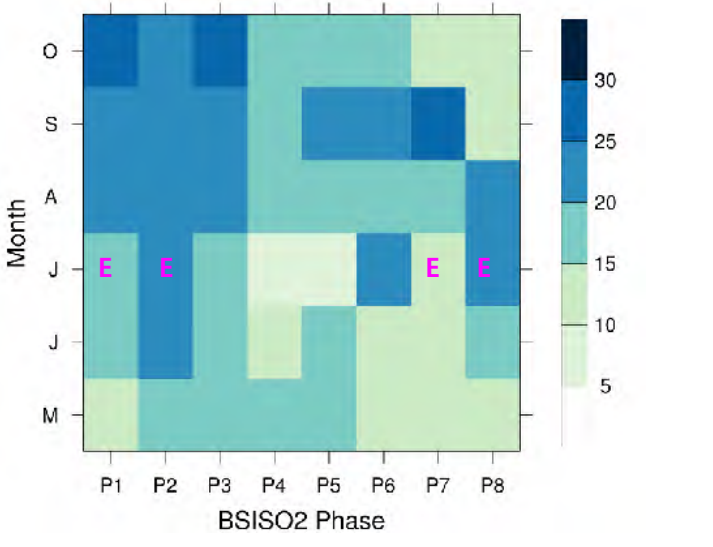


BSISO can contribute to the favorable condition in making strong Indo-China monsoon and bringing extra precipitation to TMD.

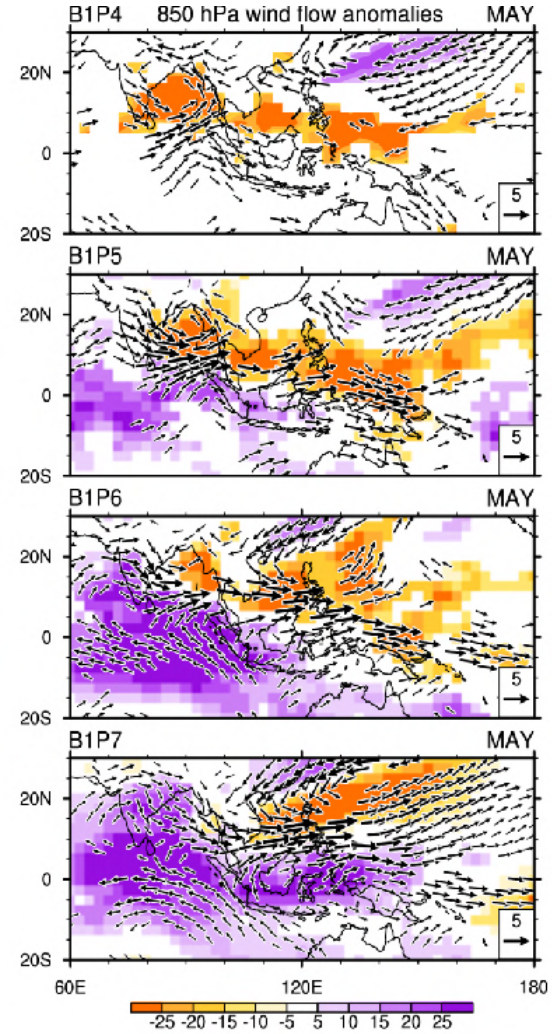


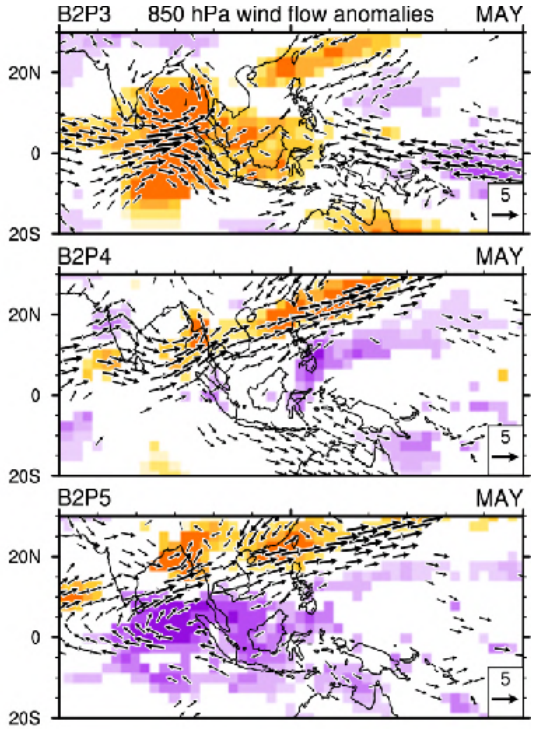


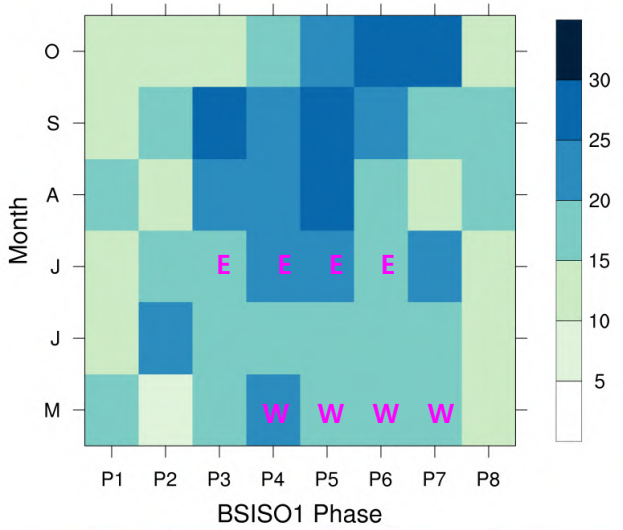


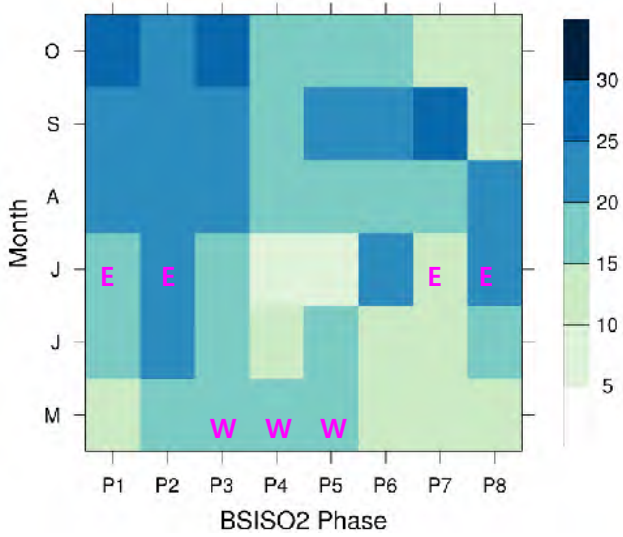


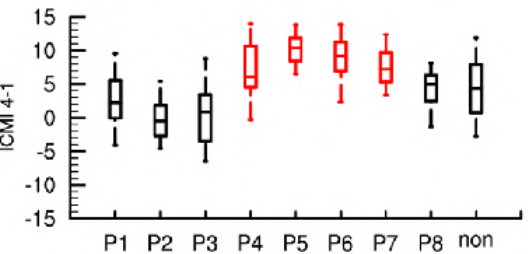
Mechanism Analysis *(BSISO-Extreme rainfall probability)*

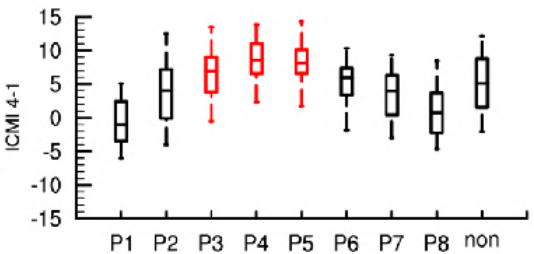












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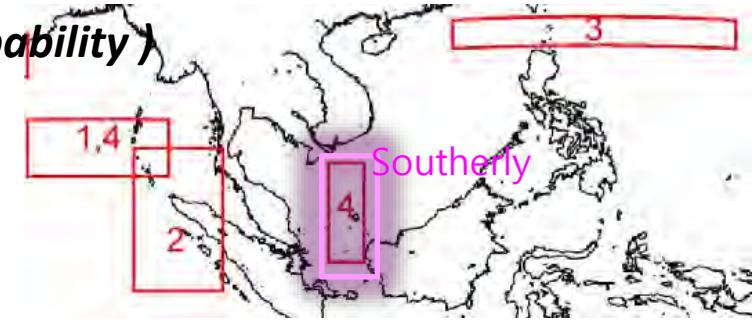
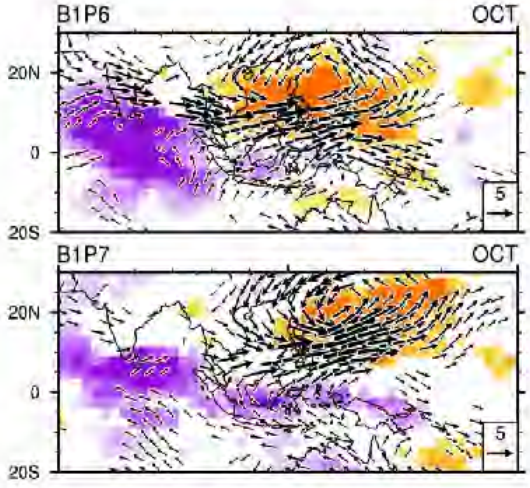
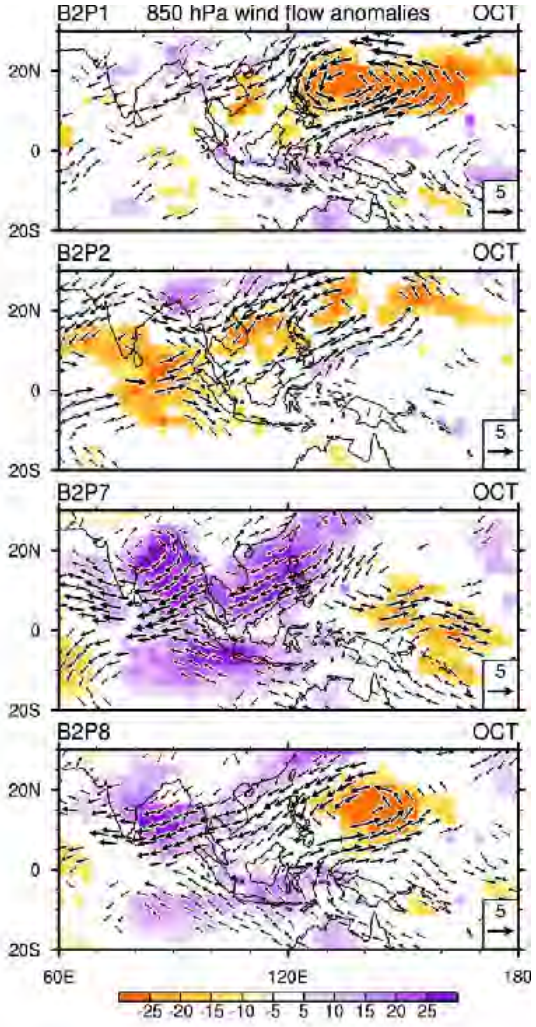
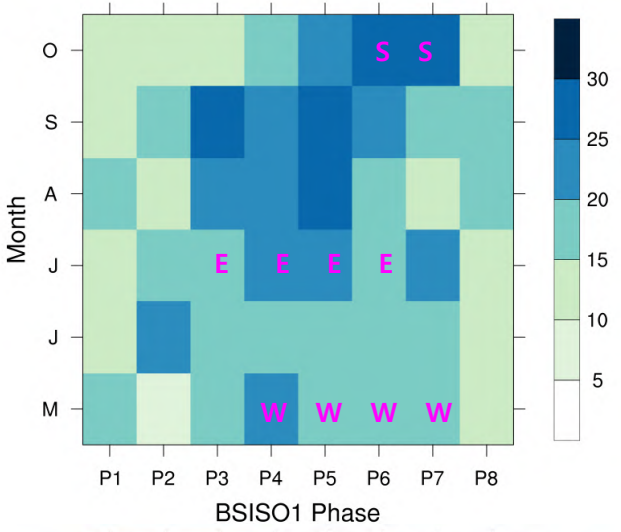
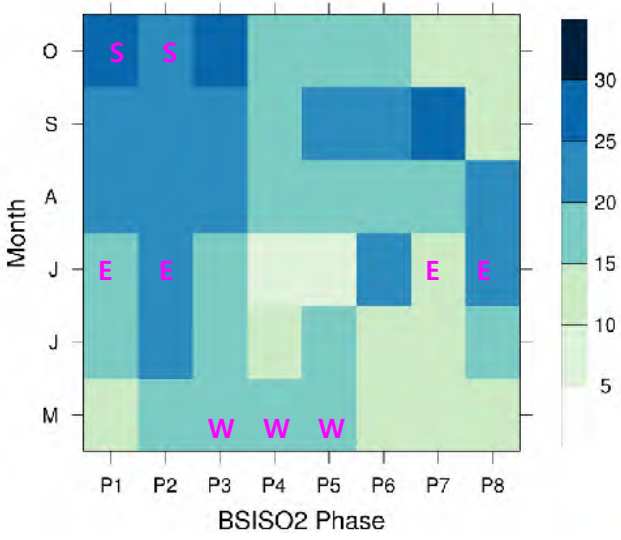
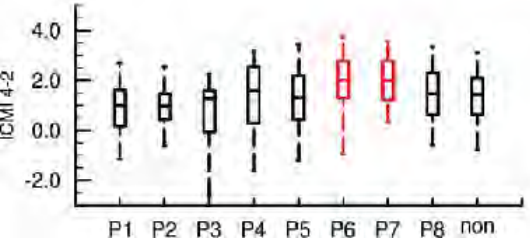


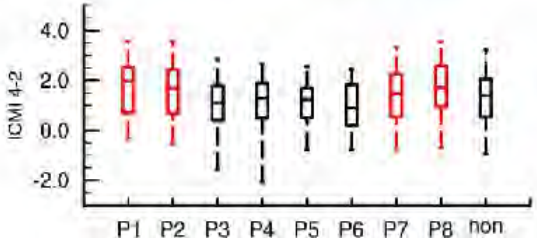






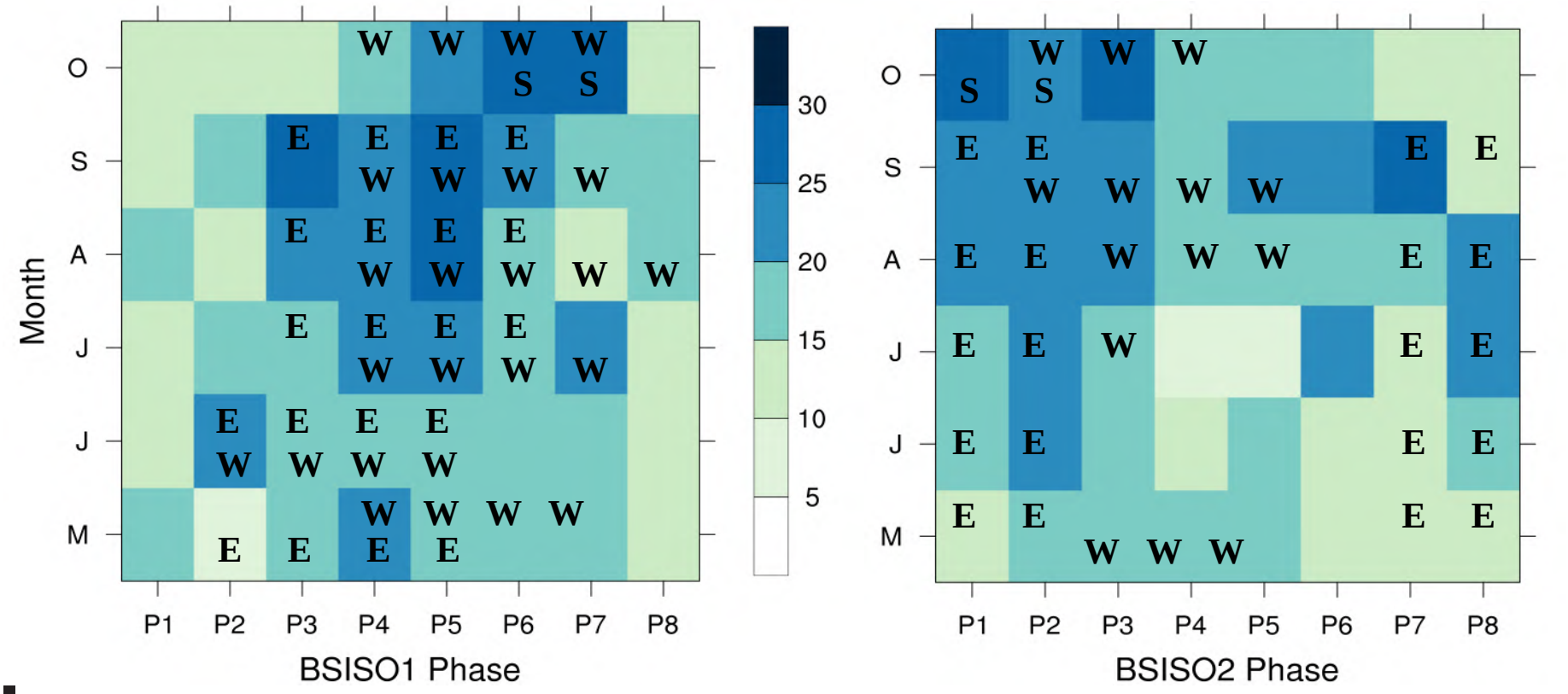






Better forecast? *practical use*

Mechanism Analysis ***(BSISO-Extreme rainfall probability)***

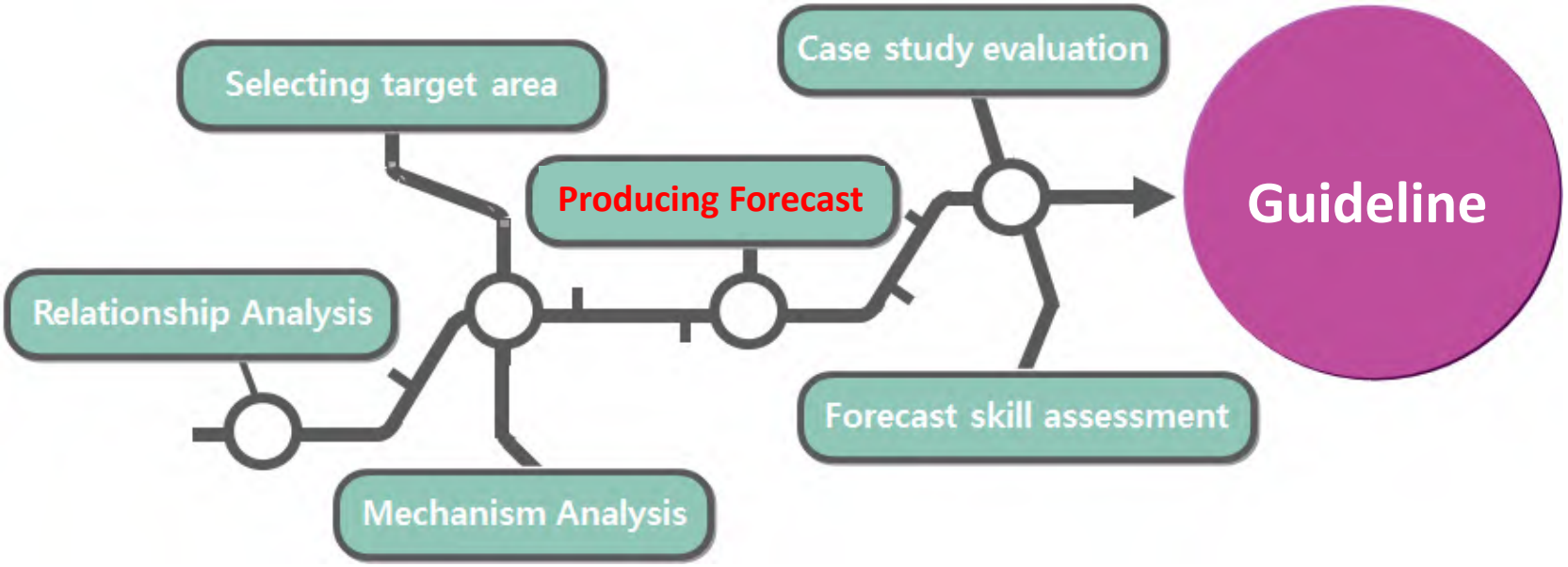


Probability table marked with favorable wind condition which can contribute strong Indo-China monsoon and bring heavy rainfall.

Better forecast? *practical use*

Strategy

'15 '16



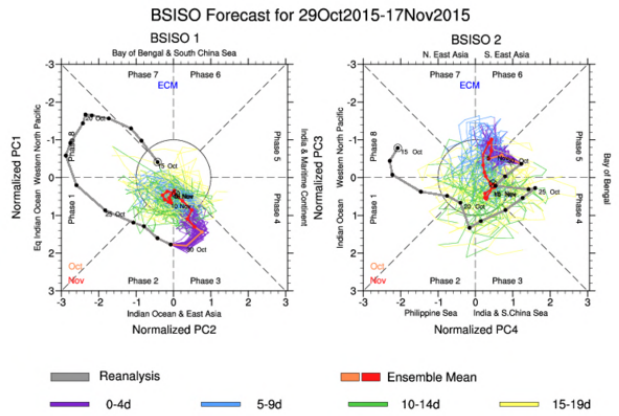
Better forecast? *practical use*

Producing Forecasts estimated by BSISO indices

BSISO real-time forecast

Note: Move cursor over product name to display. Click for additional information.

Phase Plots of BSISO Index Forecasts			
BOM	CFS	GFS	UKM
ECM	CWB		



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)

Better forecast? *practical use*

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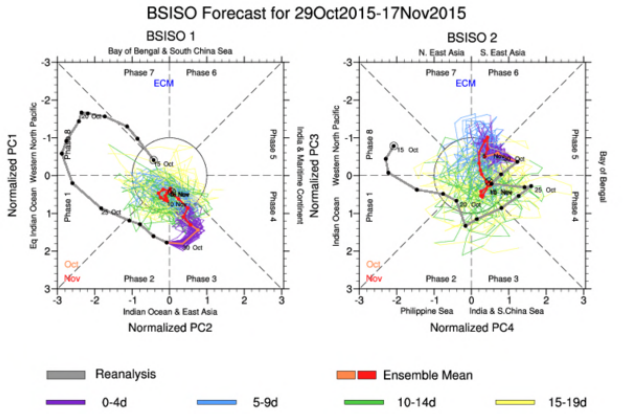

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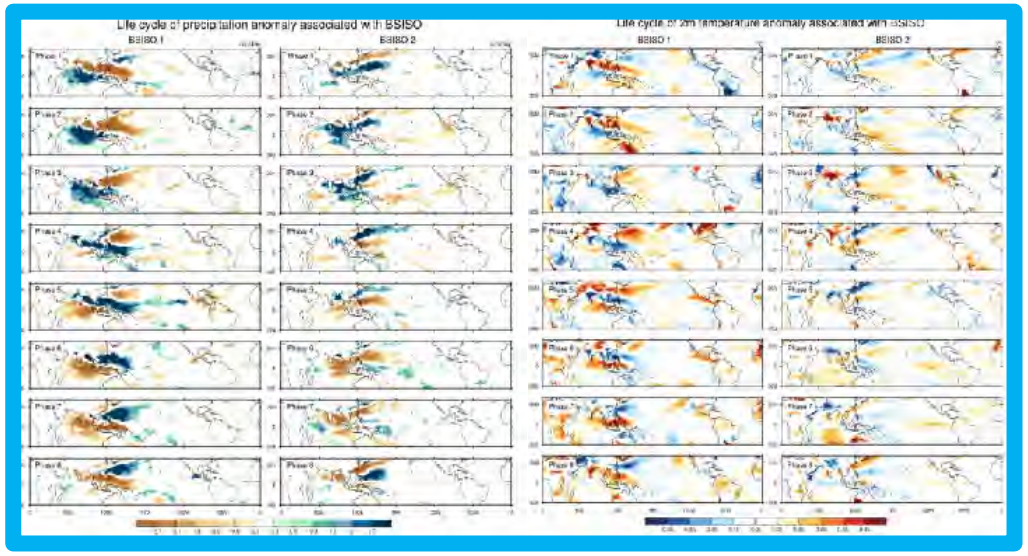
Observational relationship

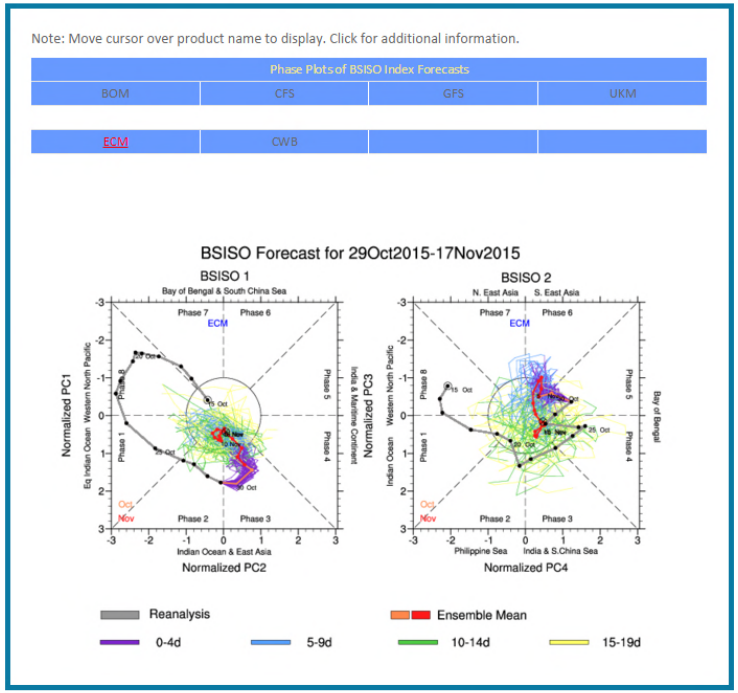


Composite Anomalies associated with the BSISO
[Mon, BSISO > 1.0]

Better forecast? *practical use*

Producing Forecasts estimated by BSISO indices

BSISO real-time forecast



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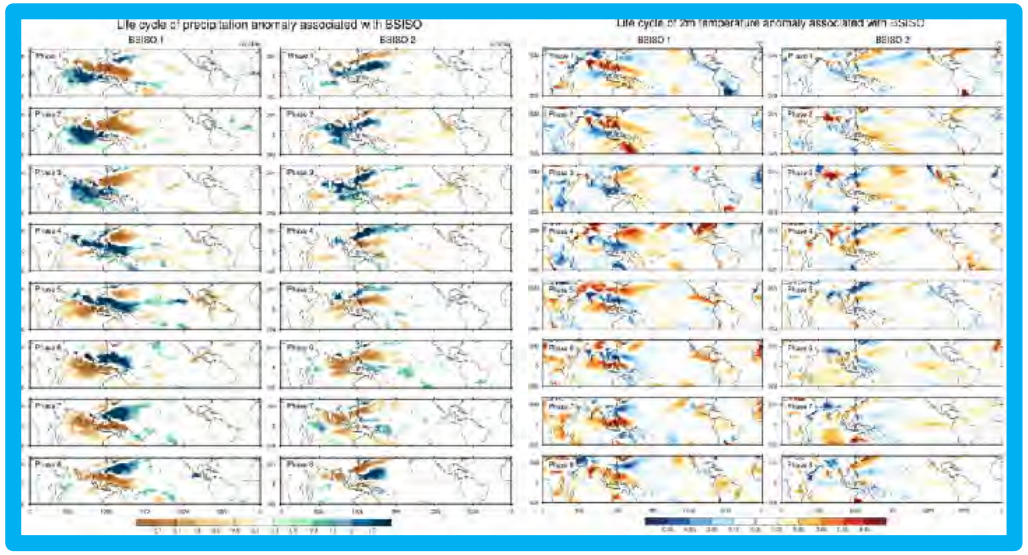
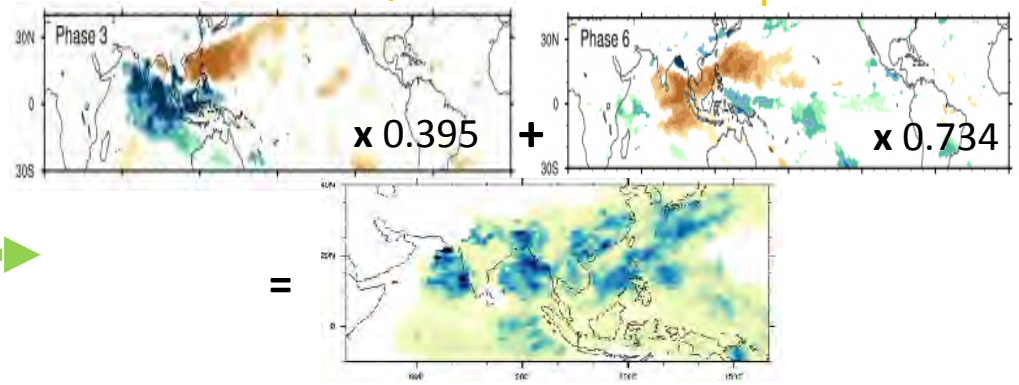


Composite Anomalies associated with the BSISO
[Mon, BSISO > 1.0]

Prediction of anomalies associated with the BSISO
B1P3 x Amp_{BSISO1} + B2P6 x Amp_{BSISO2}



Better forecast? *practical use*

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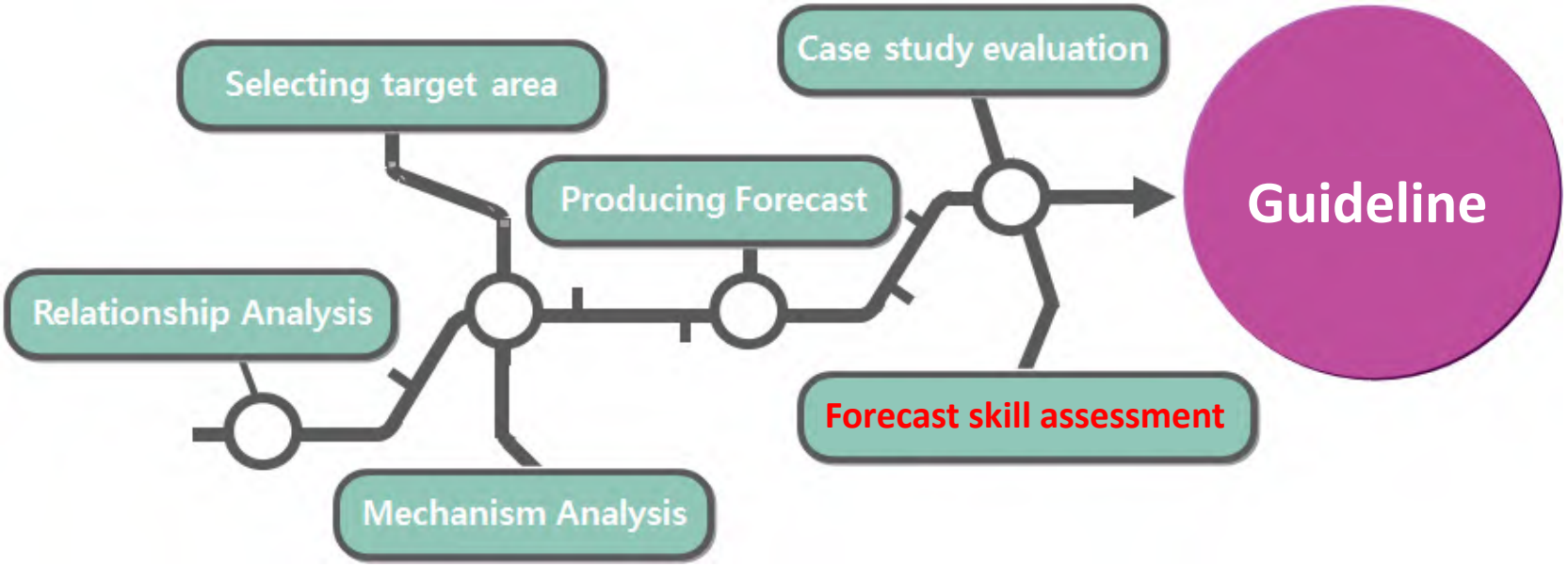


Better forecast? *practical use*

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

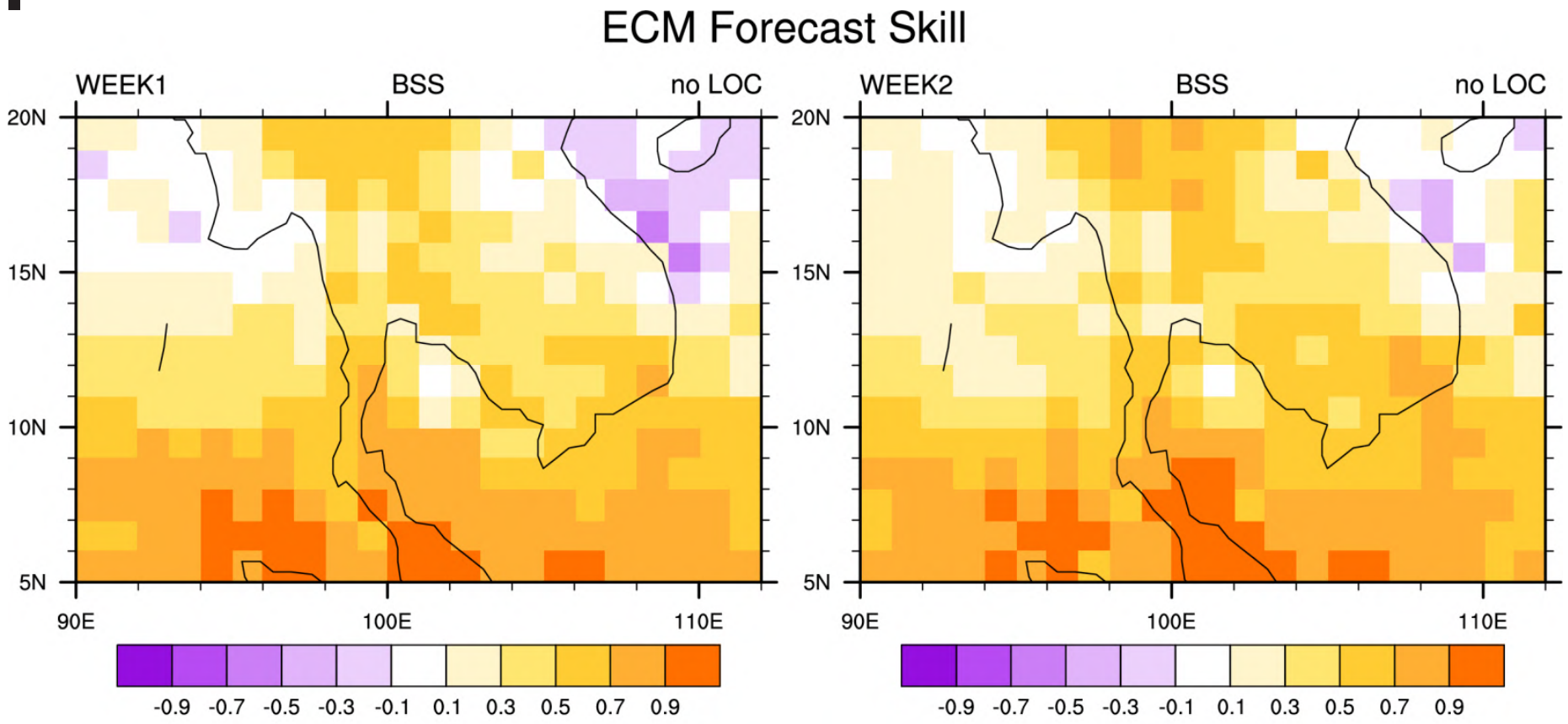
Contingency Table for multi-category forecasts

		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)

Better forecast? *practical use*

Forecast skill assessment



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

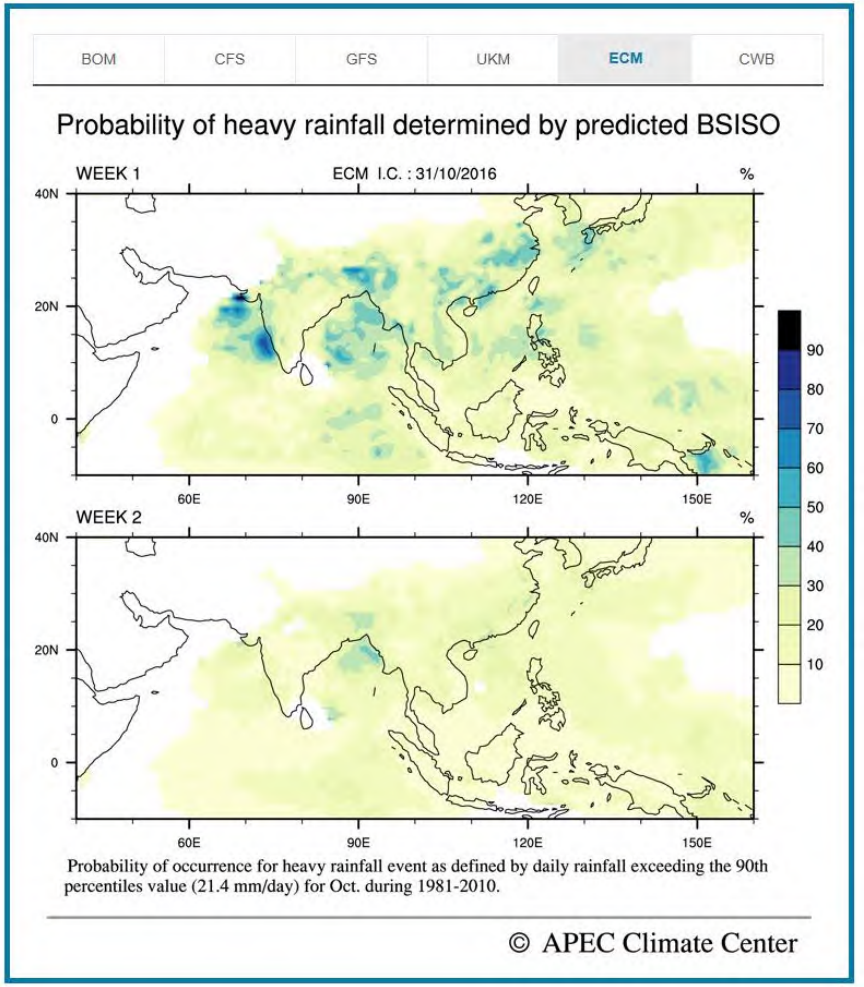
Better forecast? *practical use*

Delivery of user friendly forecast information

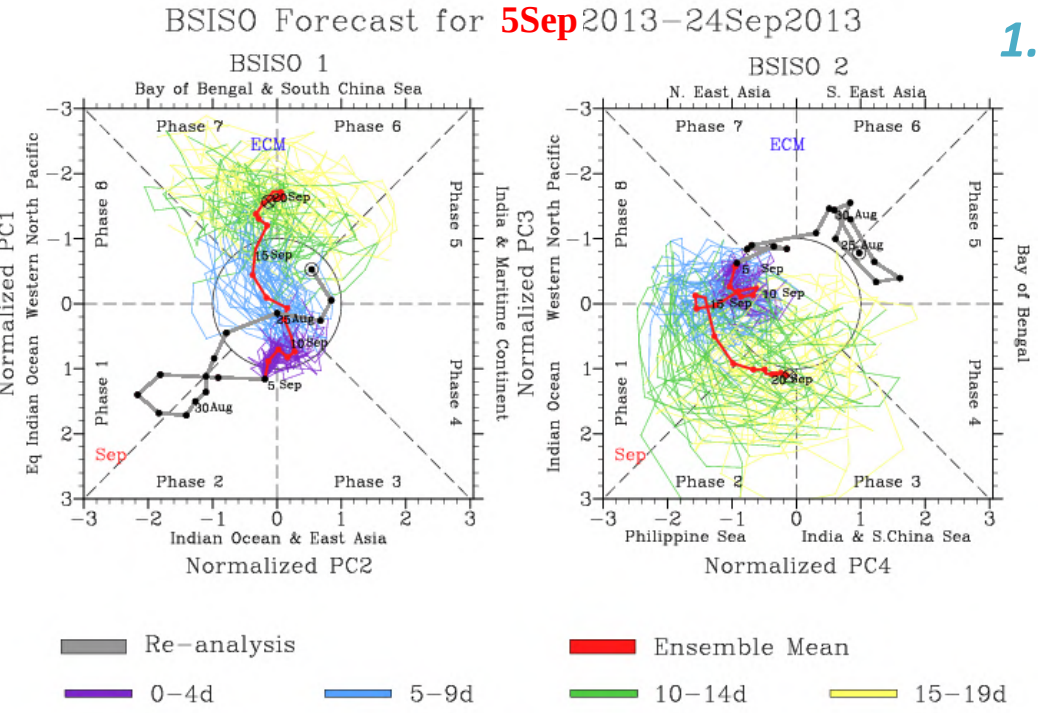
On the APCC webpage
For upcoming week1 and week2
Everyday updated

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.



Guidance

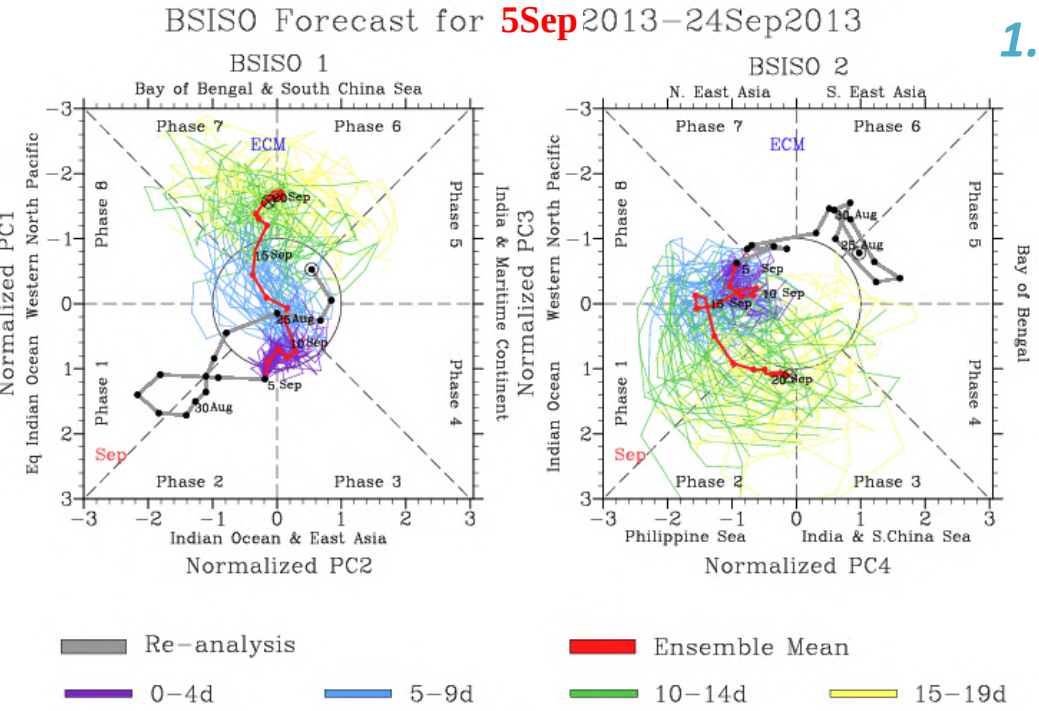


1. *Confirm the forecast of **BSISO phase** and **amplitude** for next two weeks*

→ *15-20Sep2013*

B1P7-6 , B2P1-2

Guidance



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

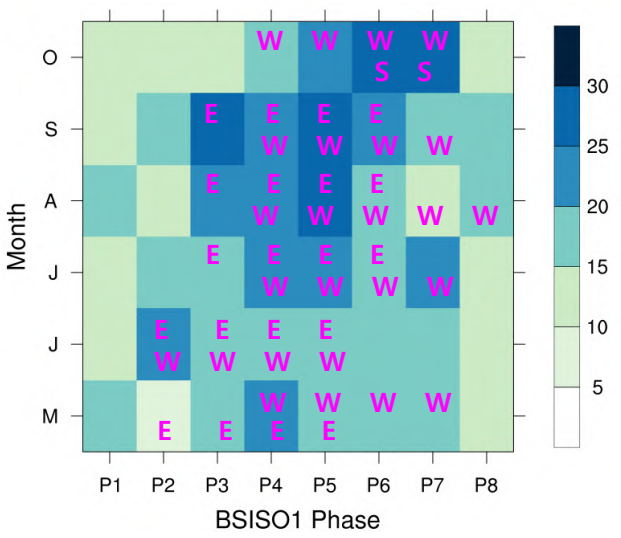
→ *15-20Sep2013*

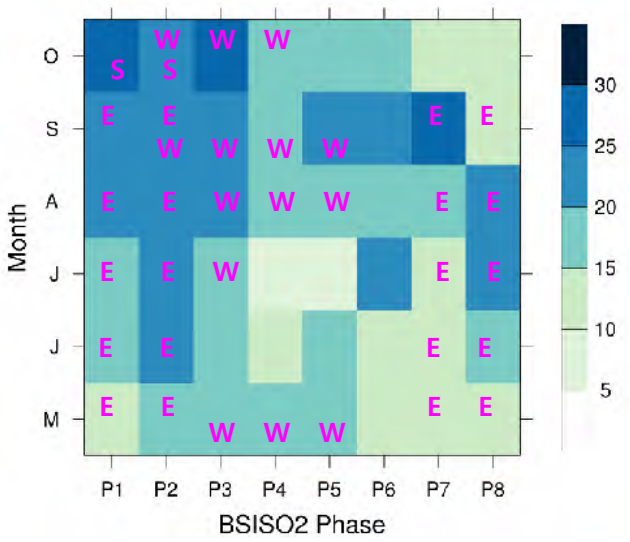
B1P7-6 , B2P1-2

2. *Find the **relationship** btw BSISO phase and heavy rainfall probability in the research report.*

→ *B1P7-6 (Sep) W,E ~20%*

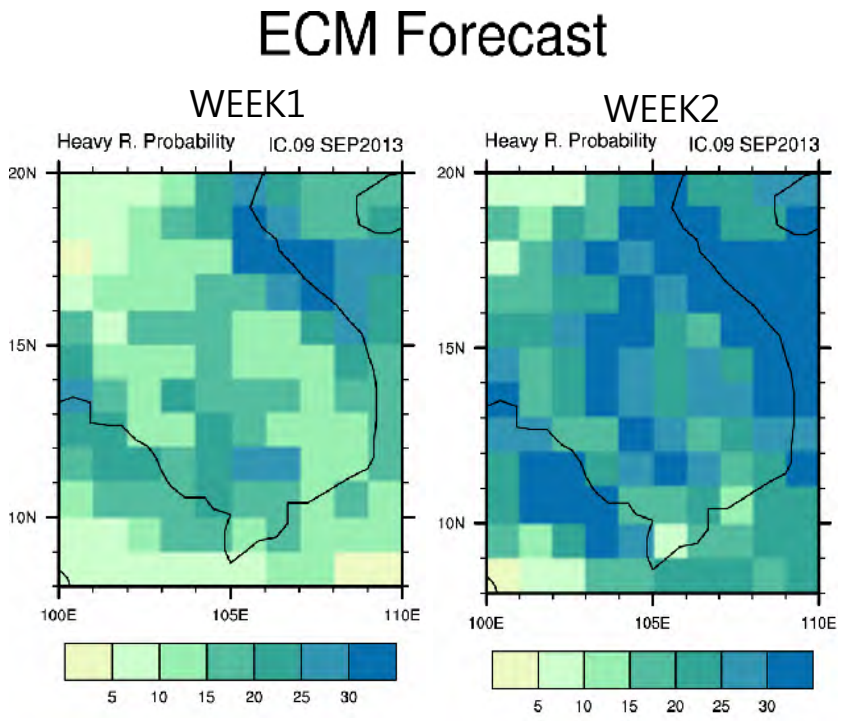
B2P1-2 (Sep) E,W ~25%

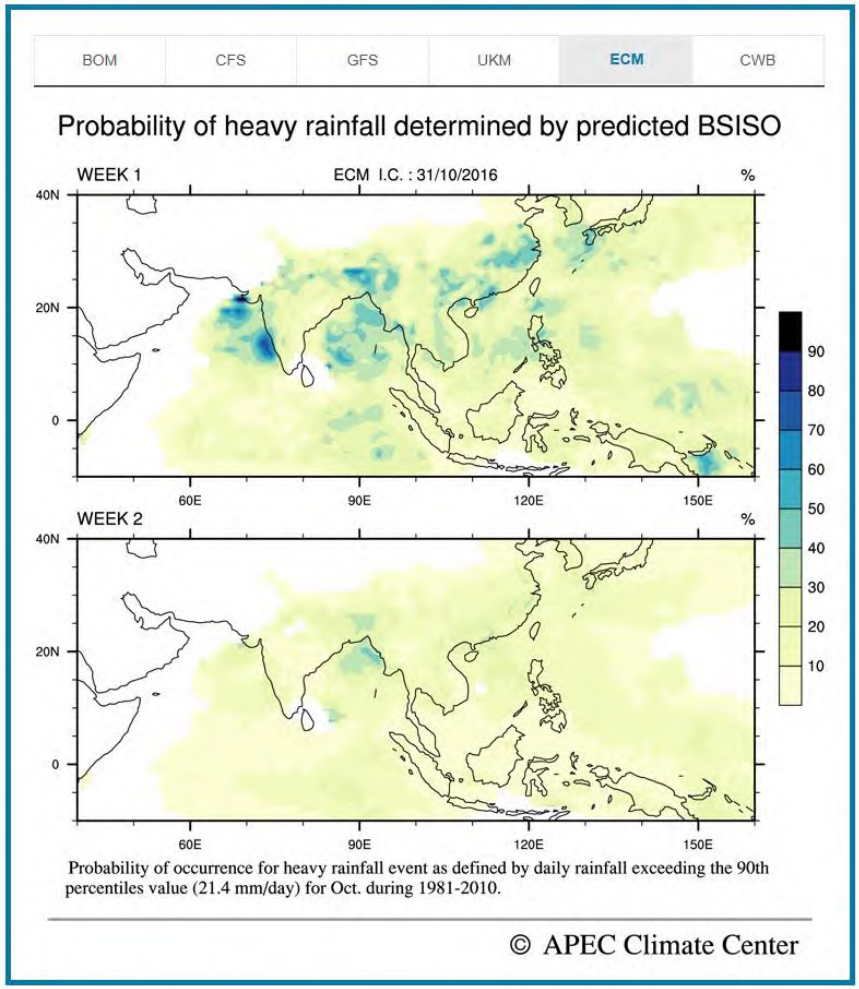




Guideline

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

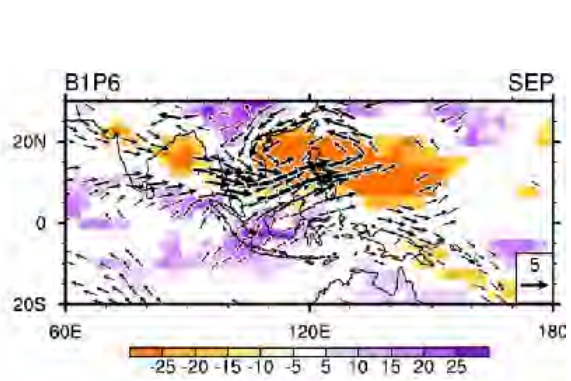


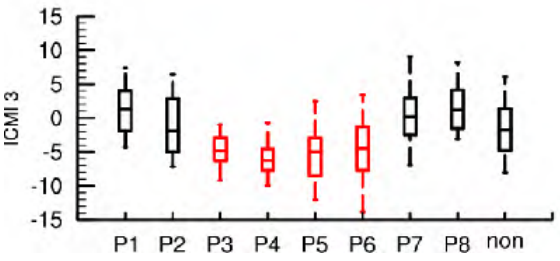


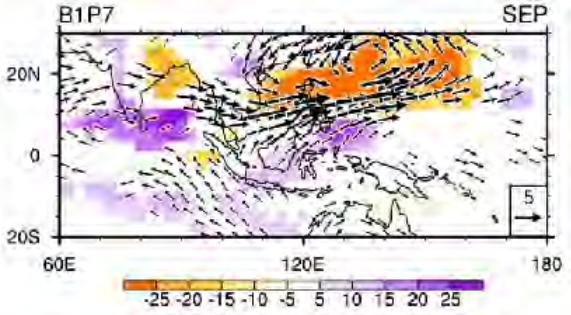
Guideline

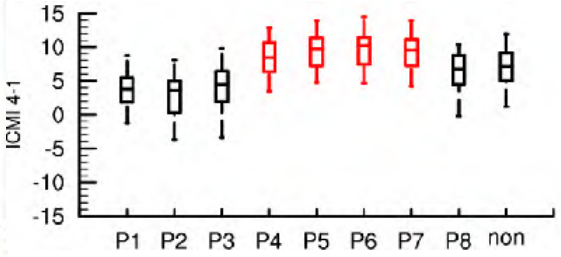
4. If you want to know the cause of easterlies and circulation pattern ..
*Look up it in the **mechanism** chapter or Appendix.*

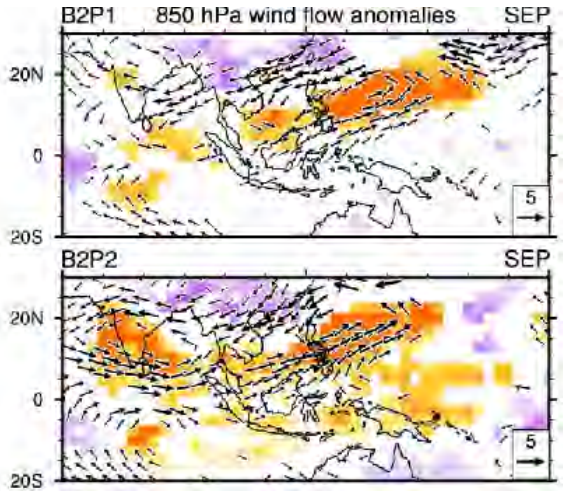
→ *Indo-china peninsular has favorable condition for having easterly (wes terly) wind due to a strong convective cell (anticyclonic cir.) located on the Philippine sea and the northwest Pacific (the Indian Ocean).*

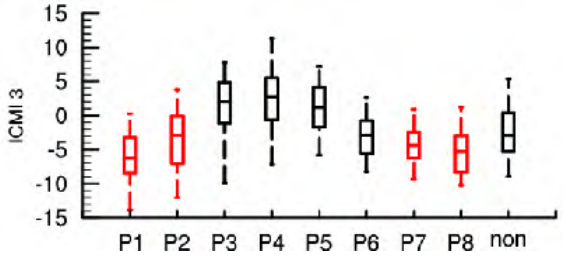








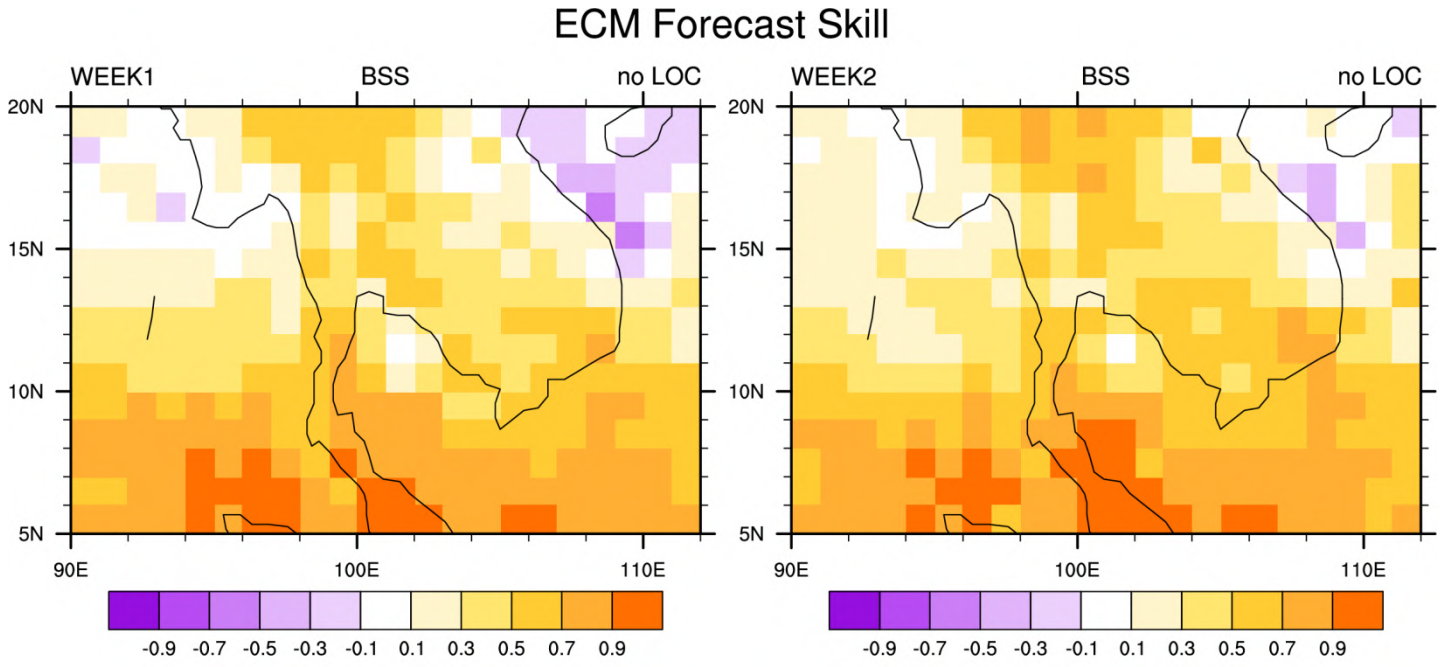




Guideline

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.*



BSISO Forecast

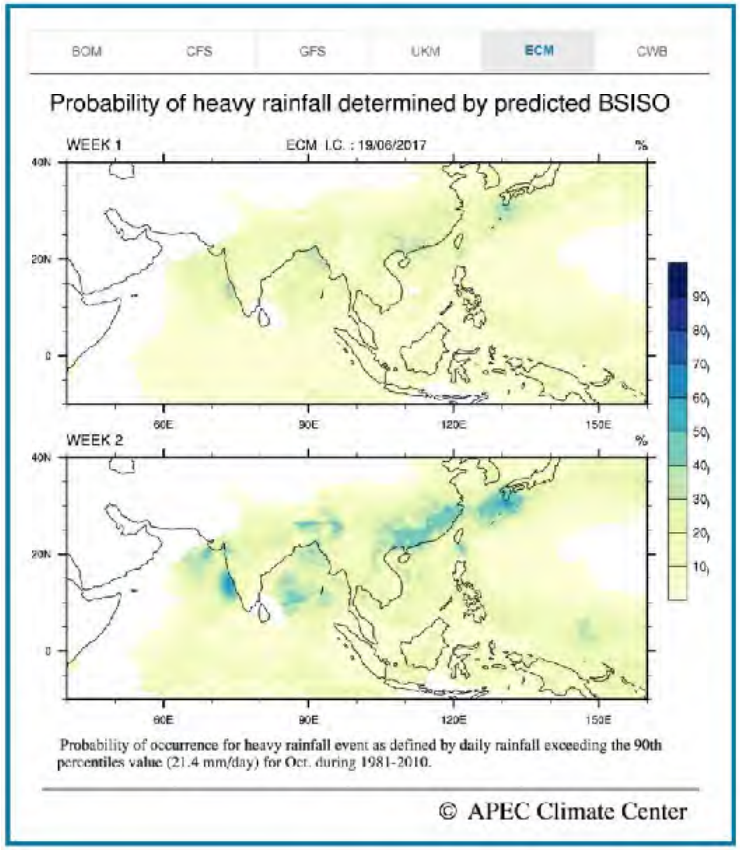
Summary

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**

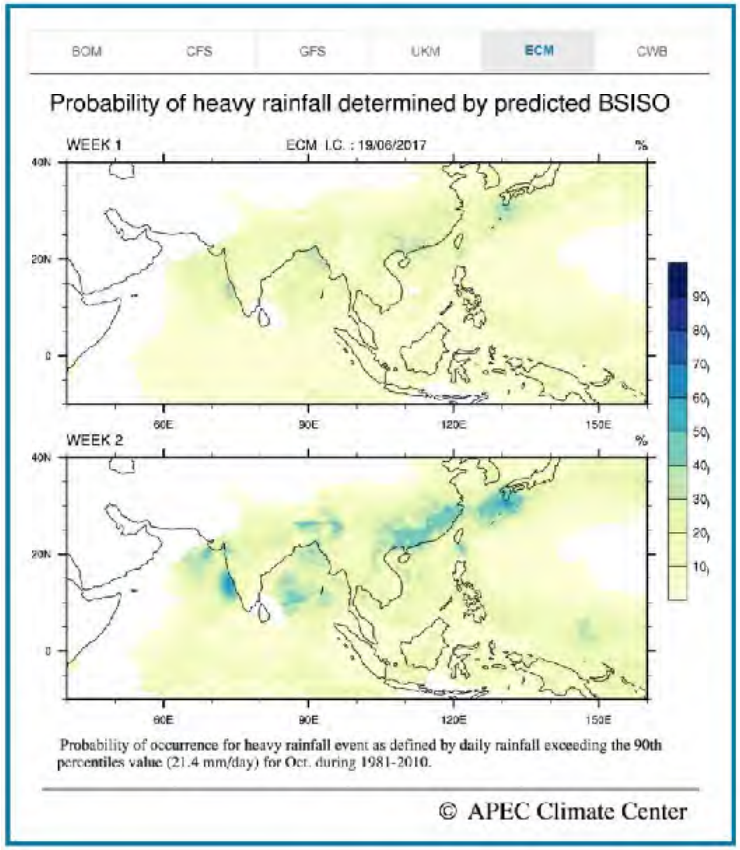


BSISO Forecast

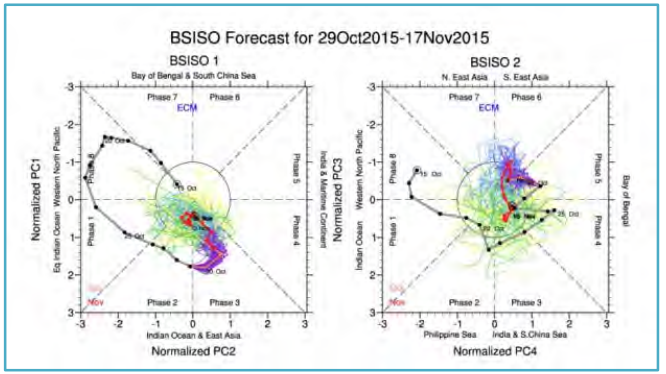
Better forecast by actionable information

Heavy rainfall forecast based on BSISO index forecast [ECMWF]

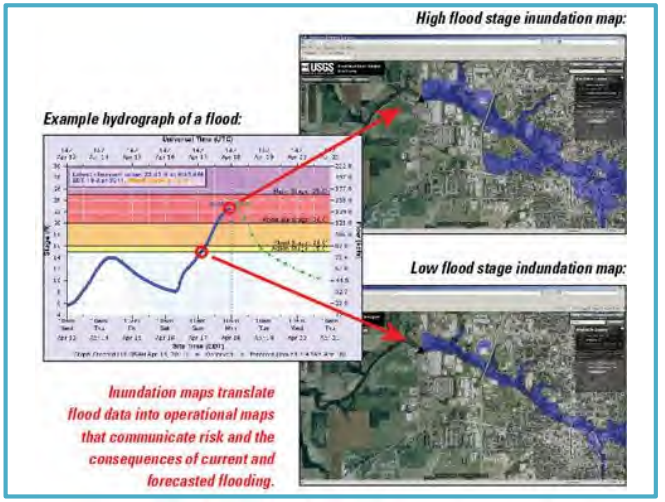
❖ **Ex> Japan flood, 398mm/4hr, July 6, 2017**



BSISO forecasts

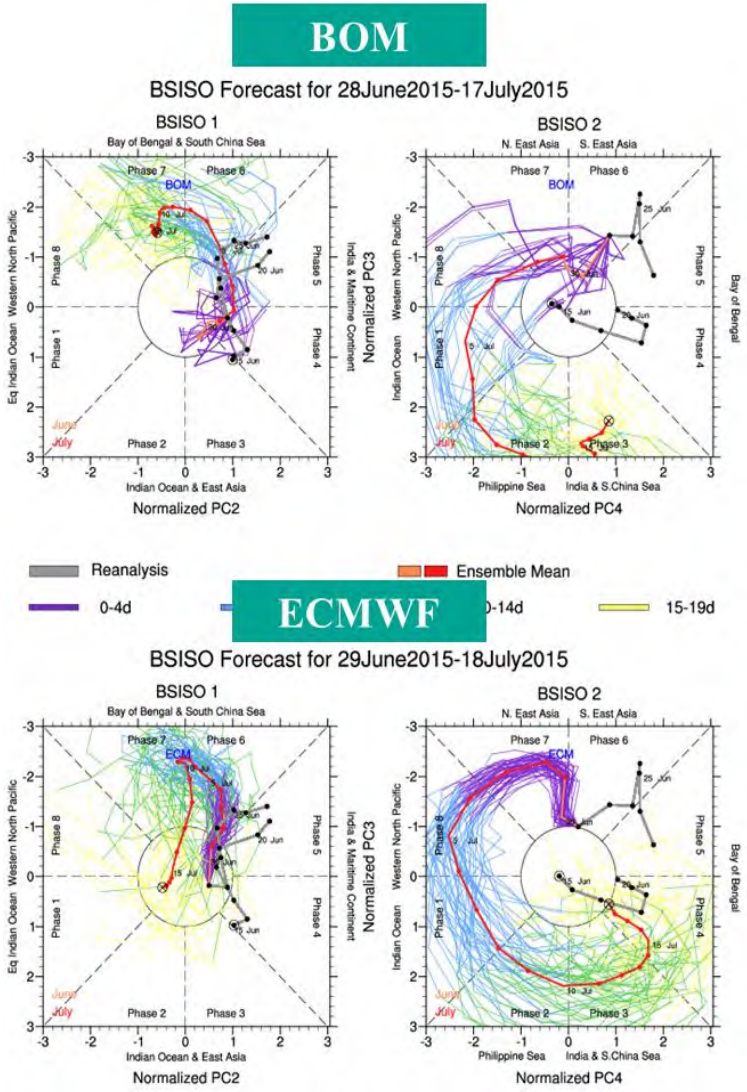


Flood Inundation Mapping



Application Possibility : Typhoon

BSISO activity in 2015



❖ BSISO1, 2에 대한 Phase 변화

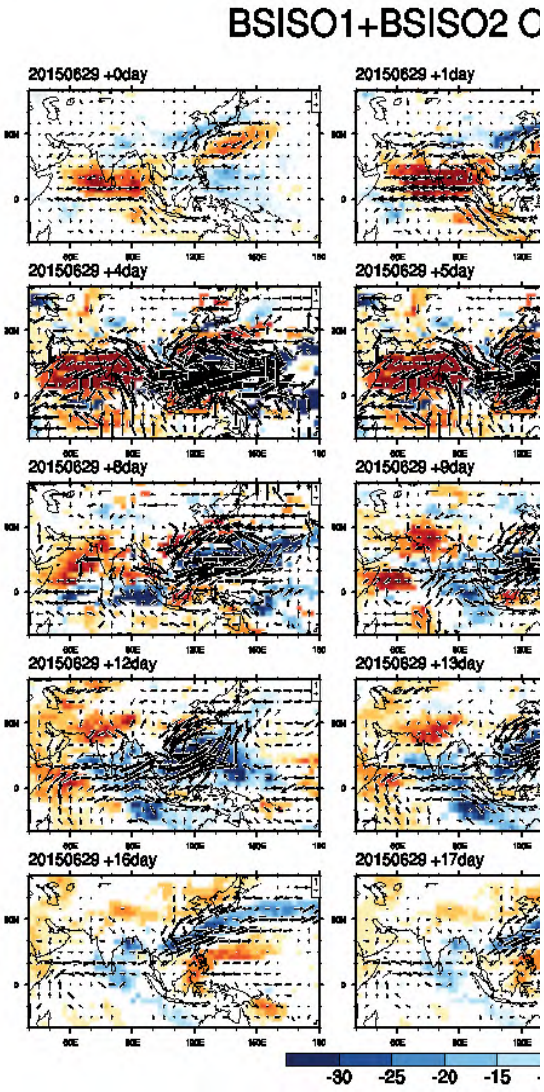
BOM	날짜	BSISO1	BSISO2
1	6/28	3	6
2	6/29	4	7
3	6/30	4	7
4	7/1	4	7
5	7/2	5	8
6	7/3	6	8
7	7/4	6	1
8	7/5	6	1
9	7/6	6	2
10	7/7	7	2
11	7/8	7	2
12	7/9	7	2
13	7/10	7	3
14	7/11	7	3
15	7/12	7	3
16	7/13	7	3
17	7/14	7	3
18	7/15	7	3
19	7/16	7	3
20	7/17	7	3

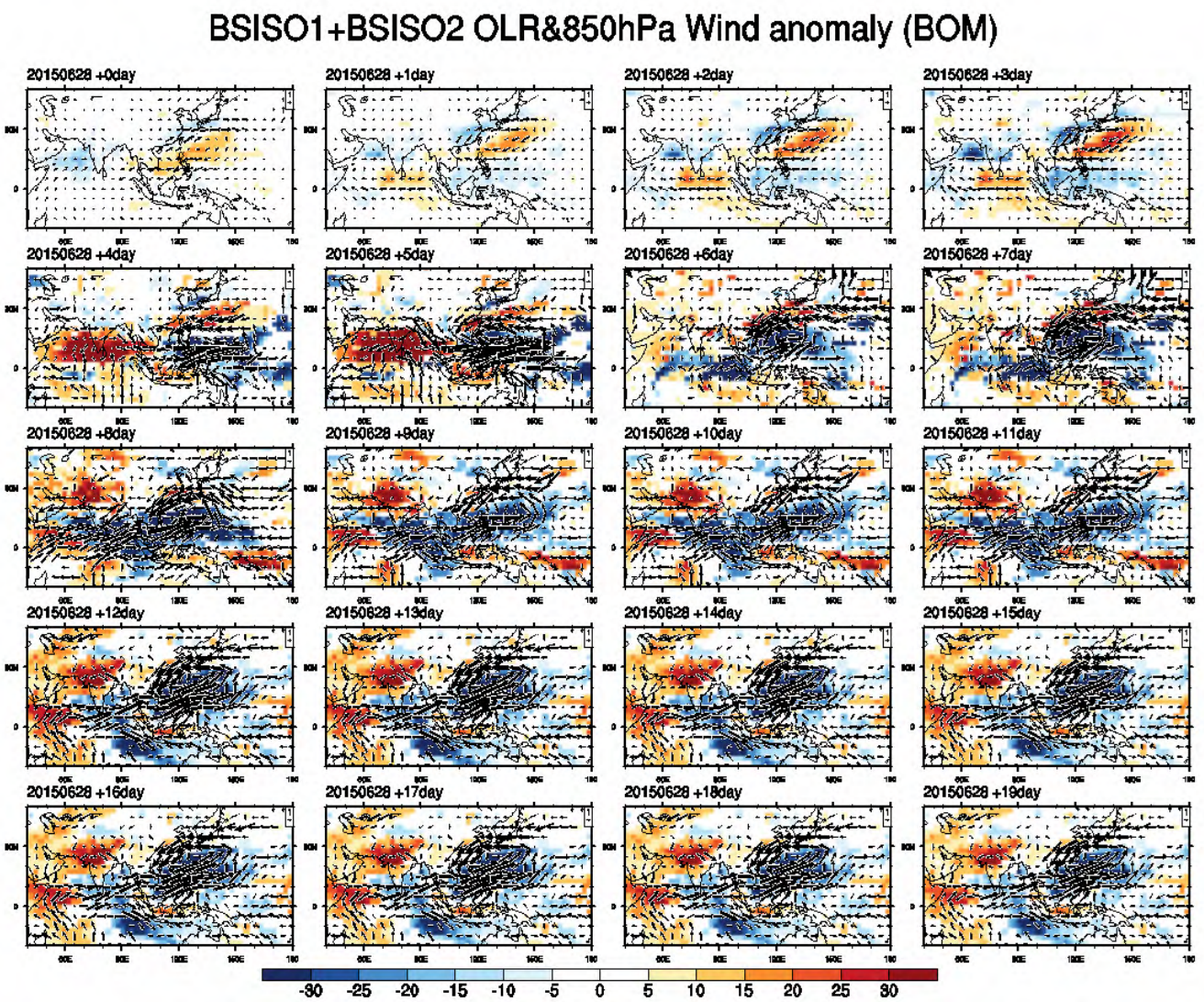
ECM	날짜	BSISO1	BSISO2
1	6/29	5	7
2	6/30	6	7
3	7/1	6	7
4	7/2	6	7
5	7/3	6	8
6	7/4	6	8
7	7/5	6	8
8	7/6	6	1
9	7/7	7	1
10	7/8	7	2
11	7/9	6	2
12	7/10	6	3
13	7/11	6	3
14	7/12	7	3
15	7/13	7	4
16	7/14	8	4
17	7/15	1	4
18	7/16	1	4
19	7/17	1	4
20	7/18	1	4

normalized amplitude가 1이상 인 경우

Application Possibility : Typhoon

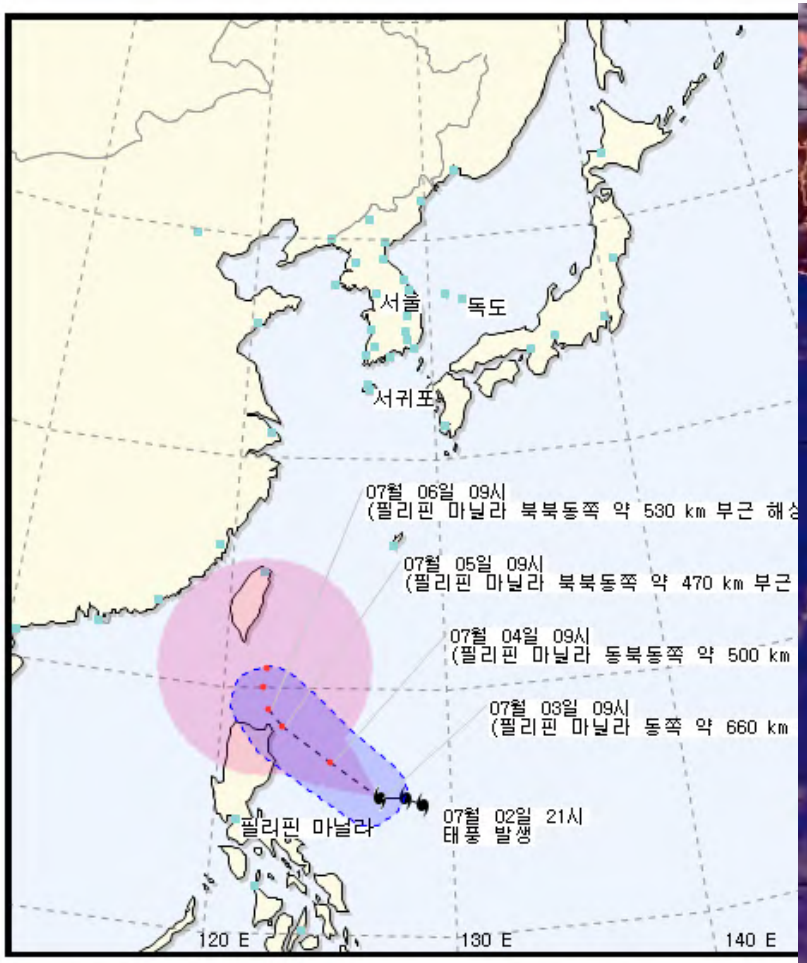
BSISO activity in 2015



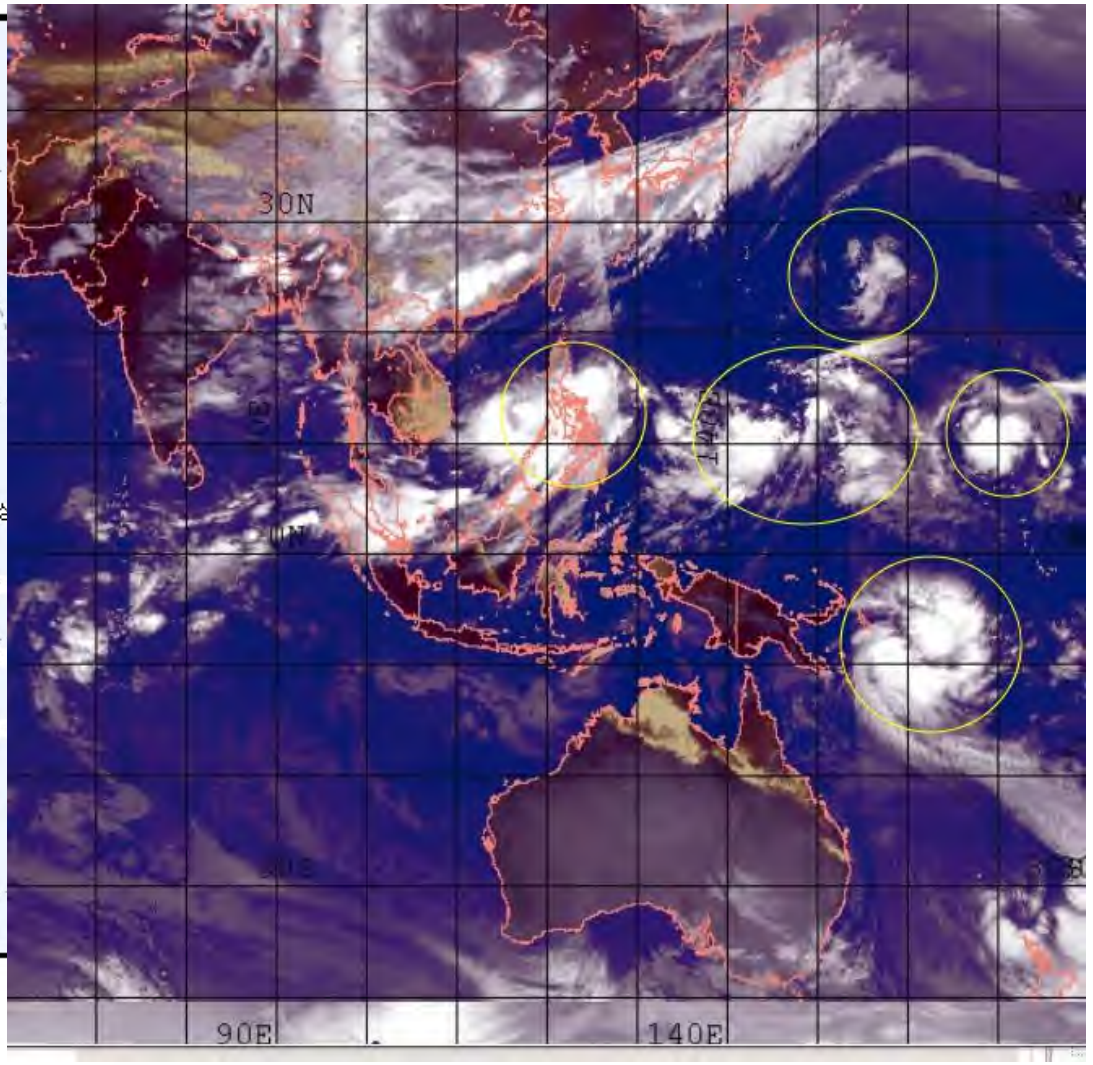


Application Possibility : Typhoon

TC activity in 2015



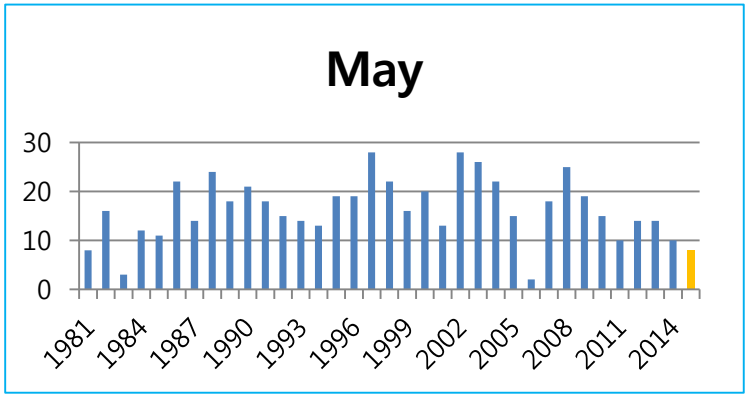
- 제10호 태풍 린파(LINFA)는 마카오에서 제출한 이름으로 연꽃을 의미함.
- 다음 정보는 오늘(3일) 16시 30분경에 발표될 예정임.
- 4일, 5일 후 태풍 위치가 유동적일 수 있으니, 이후 발표되는 기상정보에 유의바람.

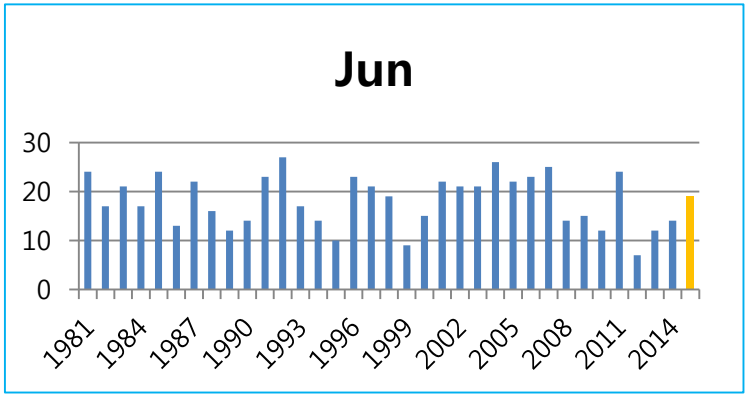


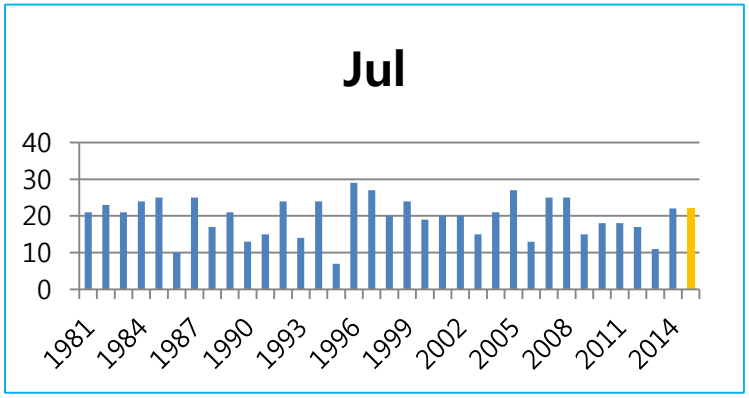
Application Possibility : Typhoon

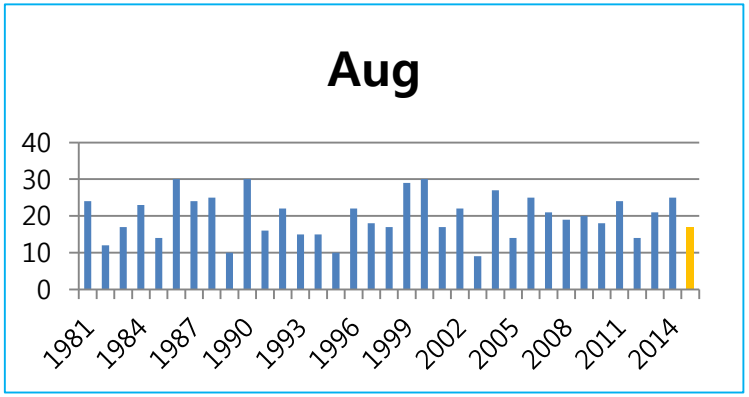
TC activity in 2015

Number of strong BSISO day (BSISO 1)





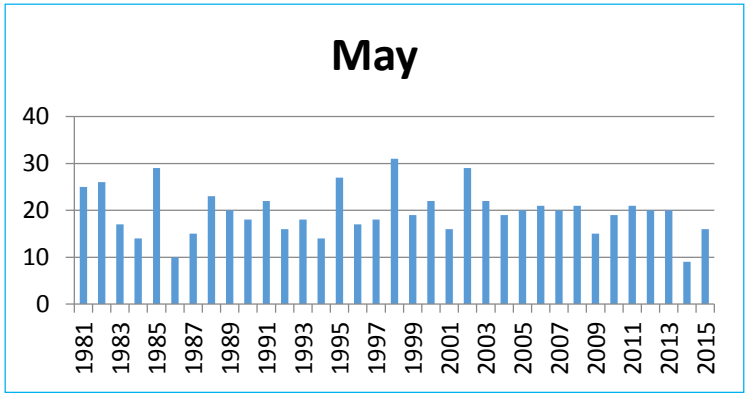


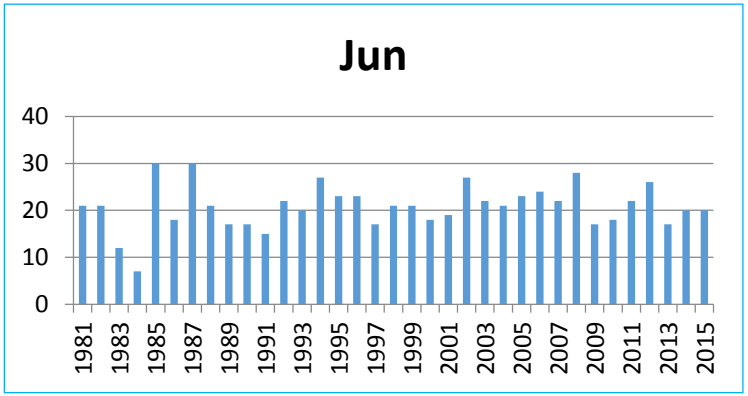


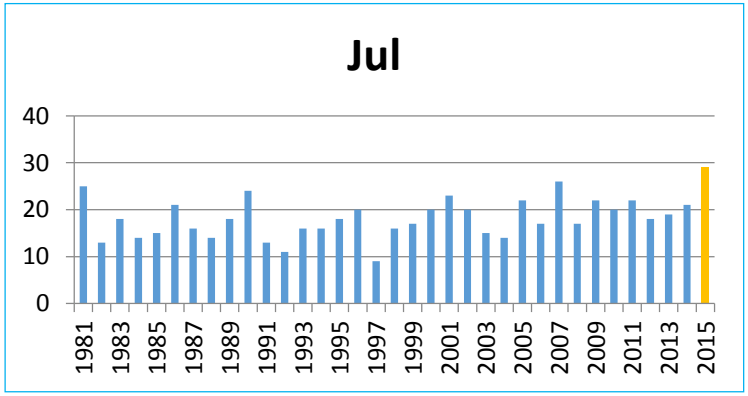
Application Possibility : Typhoon

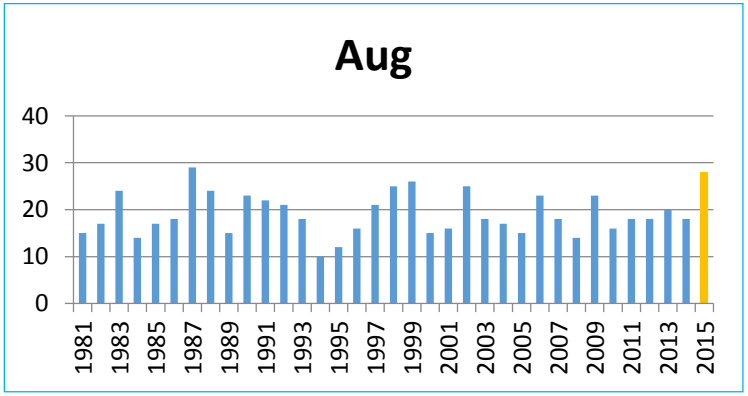
TC activity in 2015

Number of strong BSISO day (BSISO 2)





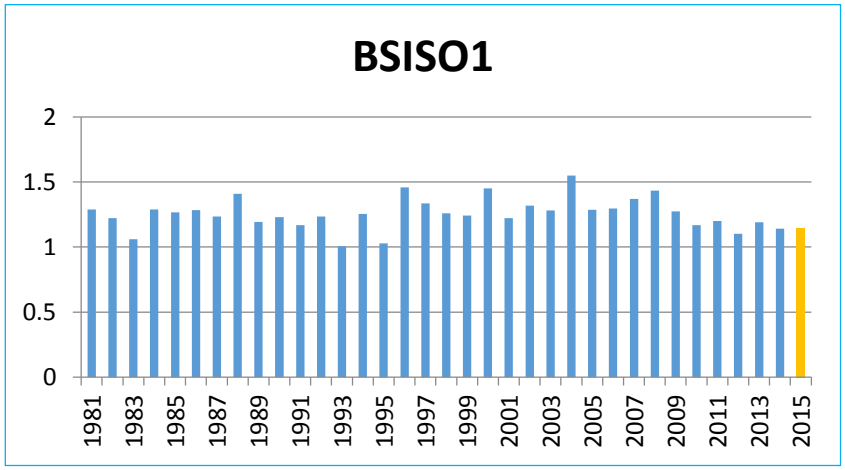


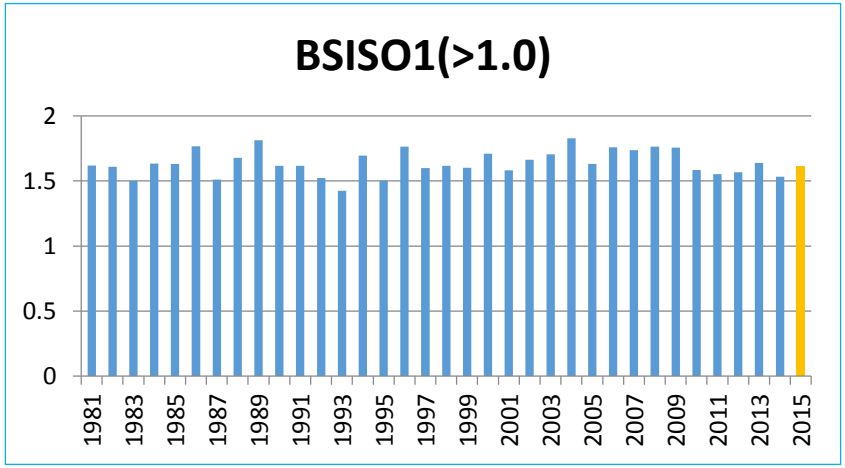


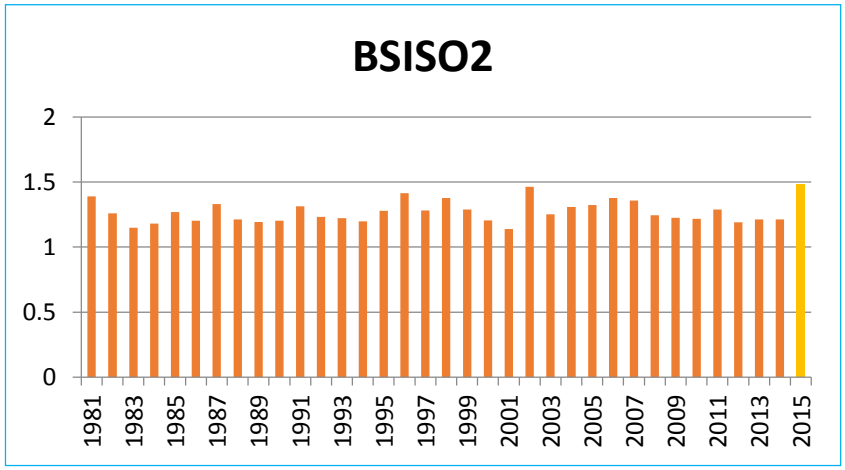
Application Possibility : Typhoon

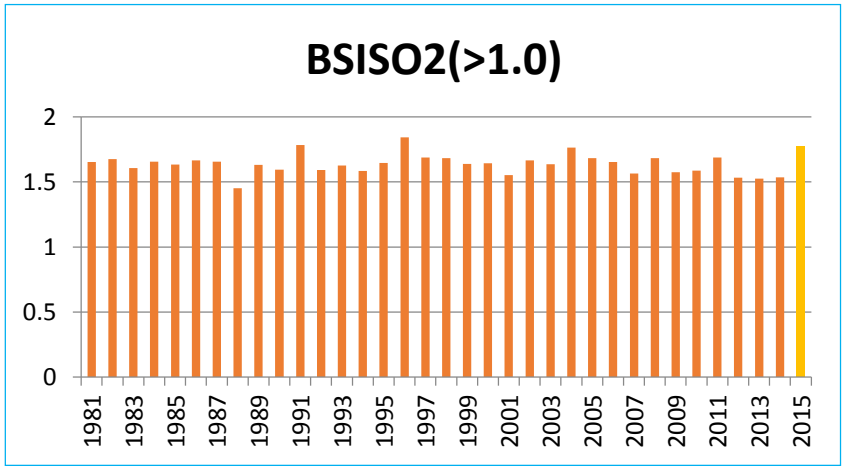
TC activity in 2015

Averaged BSISO amplitude



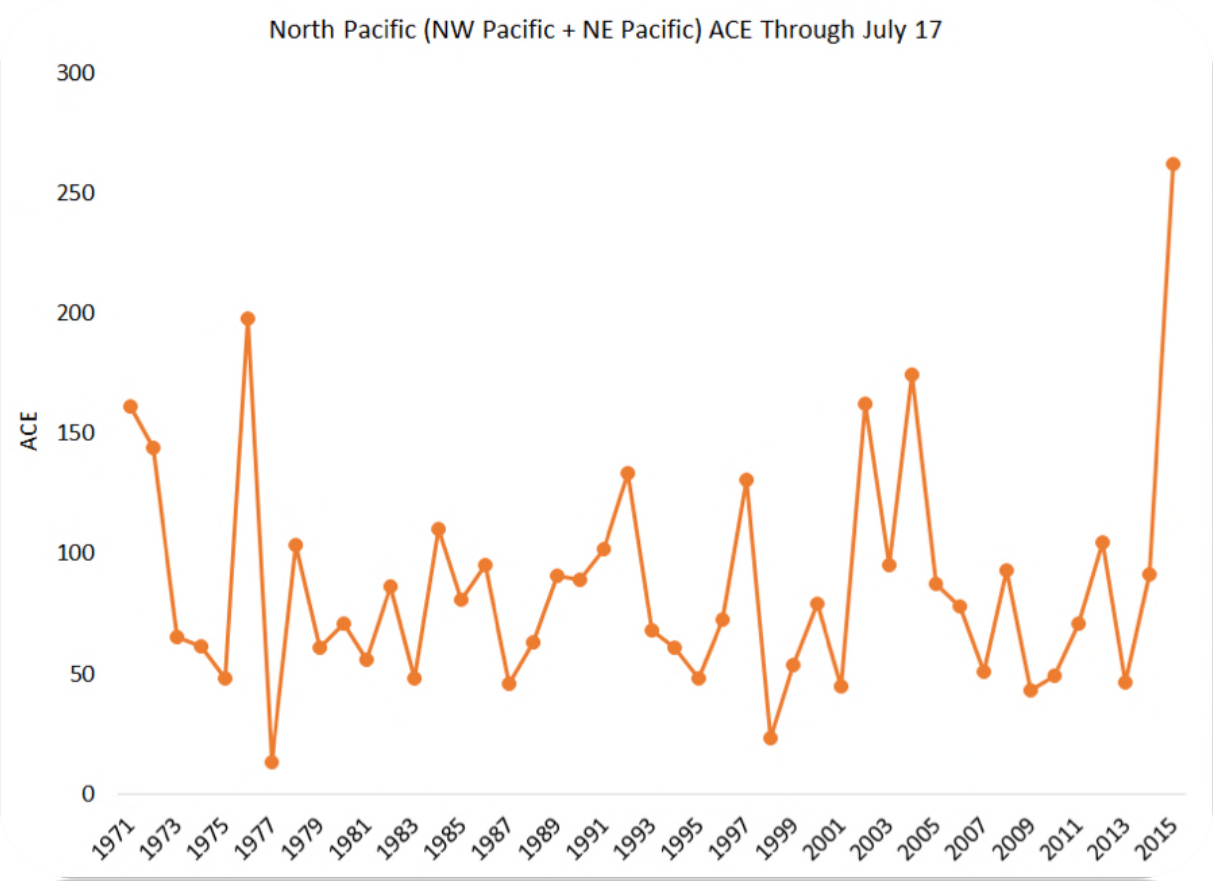






Application Possibility : Typhoon

TC activity in 2015



Source: Philip J. Klotzbach, Colorado State University

North Pacific ACE is 30% higher for this time of year than at any other time since 1971!

Application Possibility : Typhoon

TC activity in 2015

TC development in conjunction with El Nino/MJO

Source: Chris Borg, Surfline

EL NINO MEETS MJO

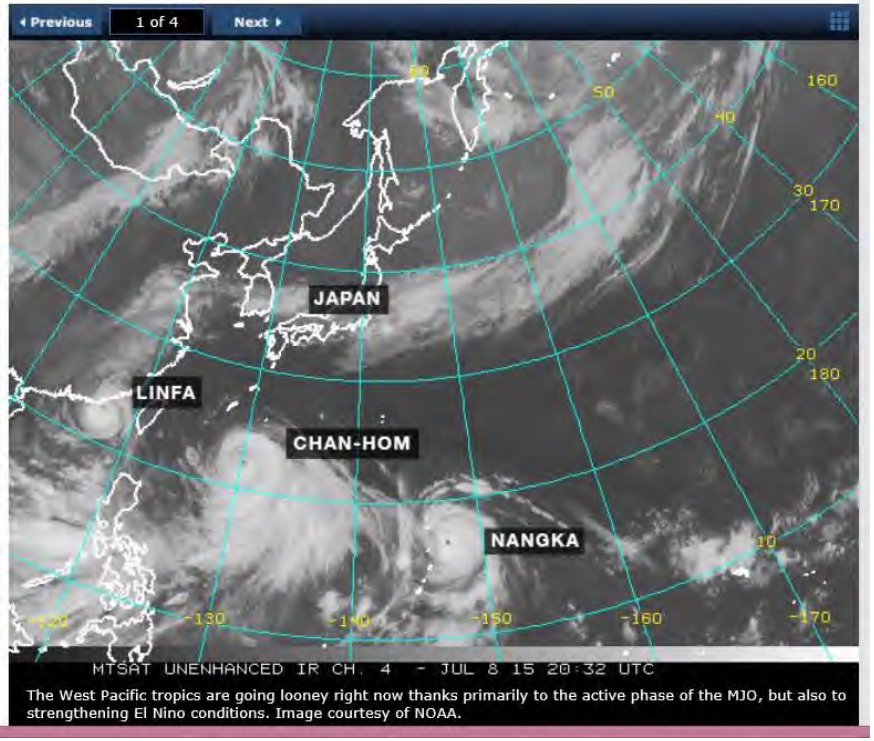
When atmospheric and oceanic oscillations combine

By Chris Borg

Published: July 8, 2015 Views: 12,189

The words "El Nino" have made their way back into the news over the last few months by slowly, but surely, warming up waters of the tropical Pacific.

Now that El Nino has strengthened and is on the verge of breaking some temperature records in the central tropics, the world's best known atmospheric/oceanic event is being credited with causing nearly every weather anomaly anywhere in the Pacific. Of course not all of those claims are valid. While El Nino is definitely the star of the show, there are other players involved too. Like the MJO, for instance.

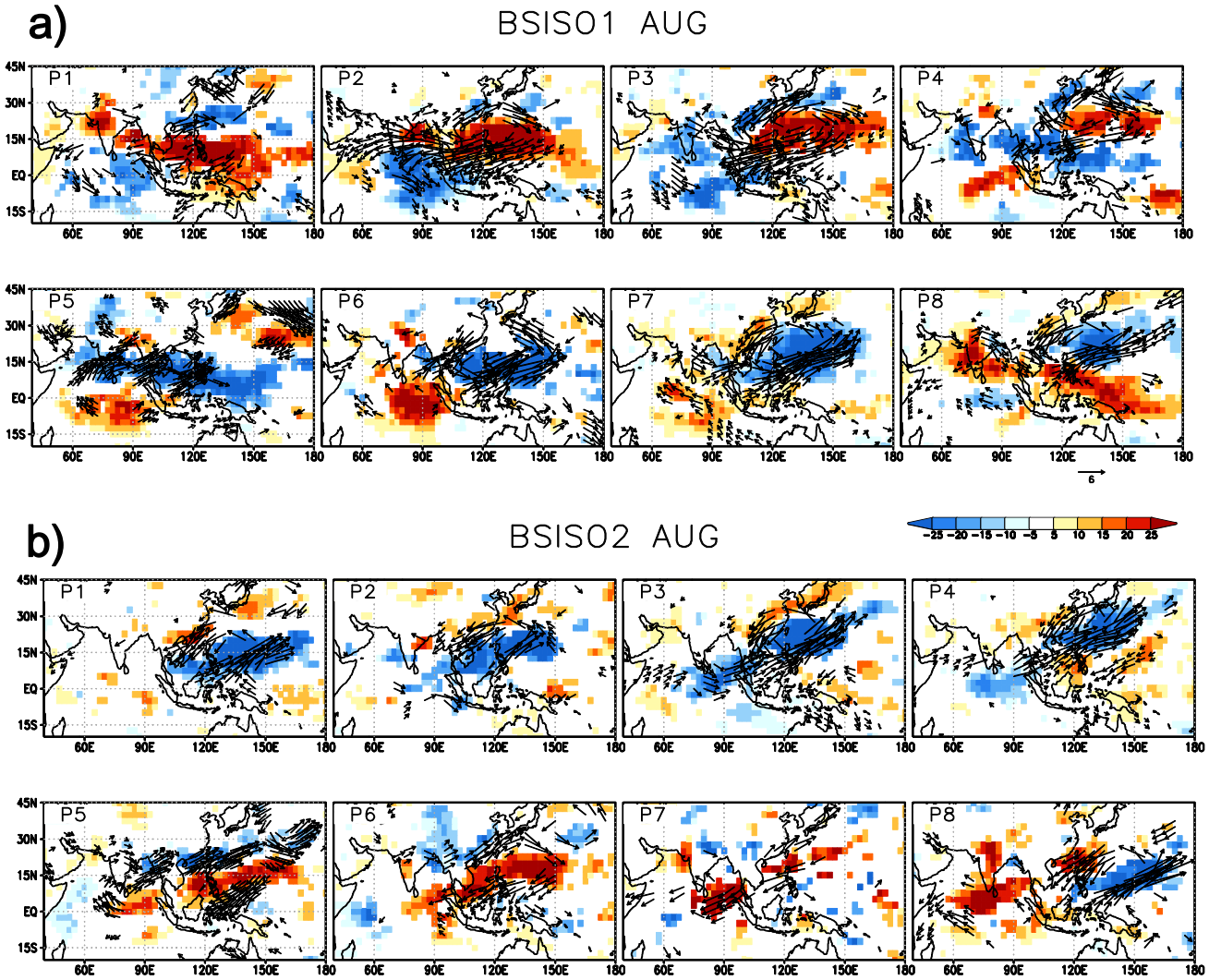


The West Pacific tropics are going looney right now thanks primarily to the active phase of the MJO, but also to strengthening El Nino conditions. Image courtesy of NOAA.

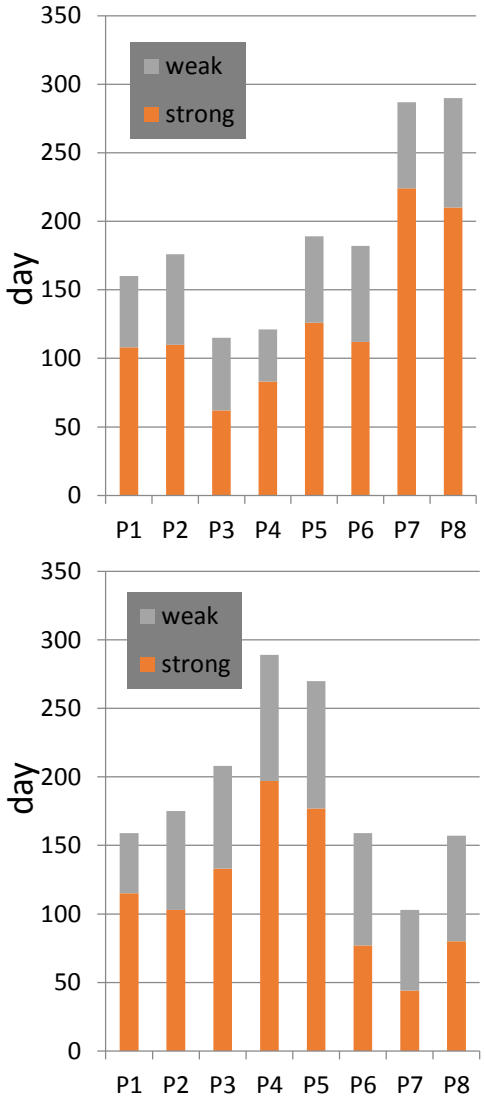
Application Possibility : Typhoon

BSISO-TC activity relationship

OLR & 850hPa wind composite anomaly

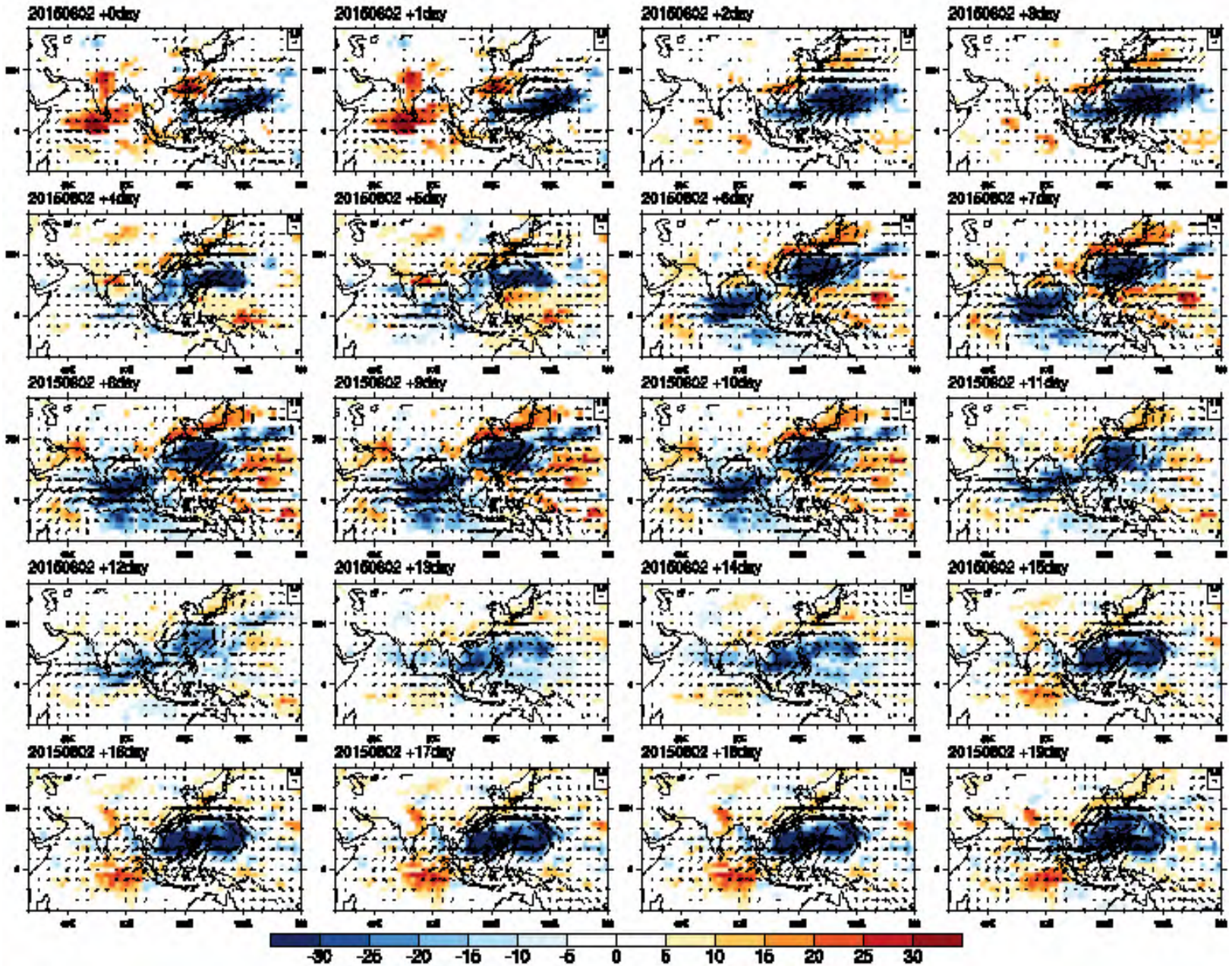


BSISO-TC relationship



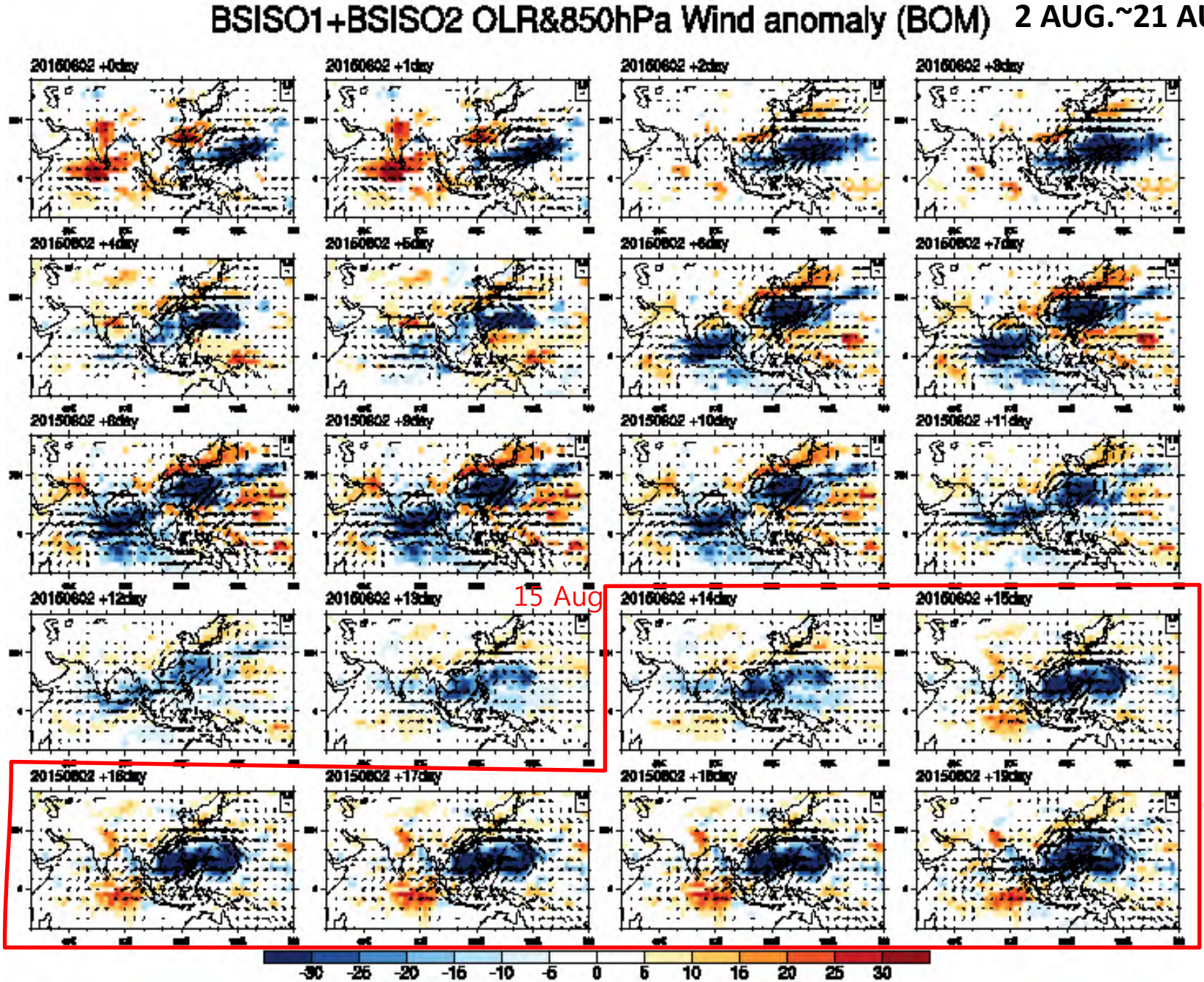
Application Possibility : Typhoon

2016
2 AUG.~21 AUG.



Application Possibility : Typhoon

2016
2 AUG.~21 AUG.



Application Possibility : Typhoon

BSISO-TC activity relationship

Is there any relationship between strong BSISO activity and TC activity in 2015?

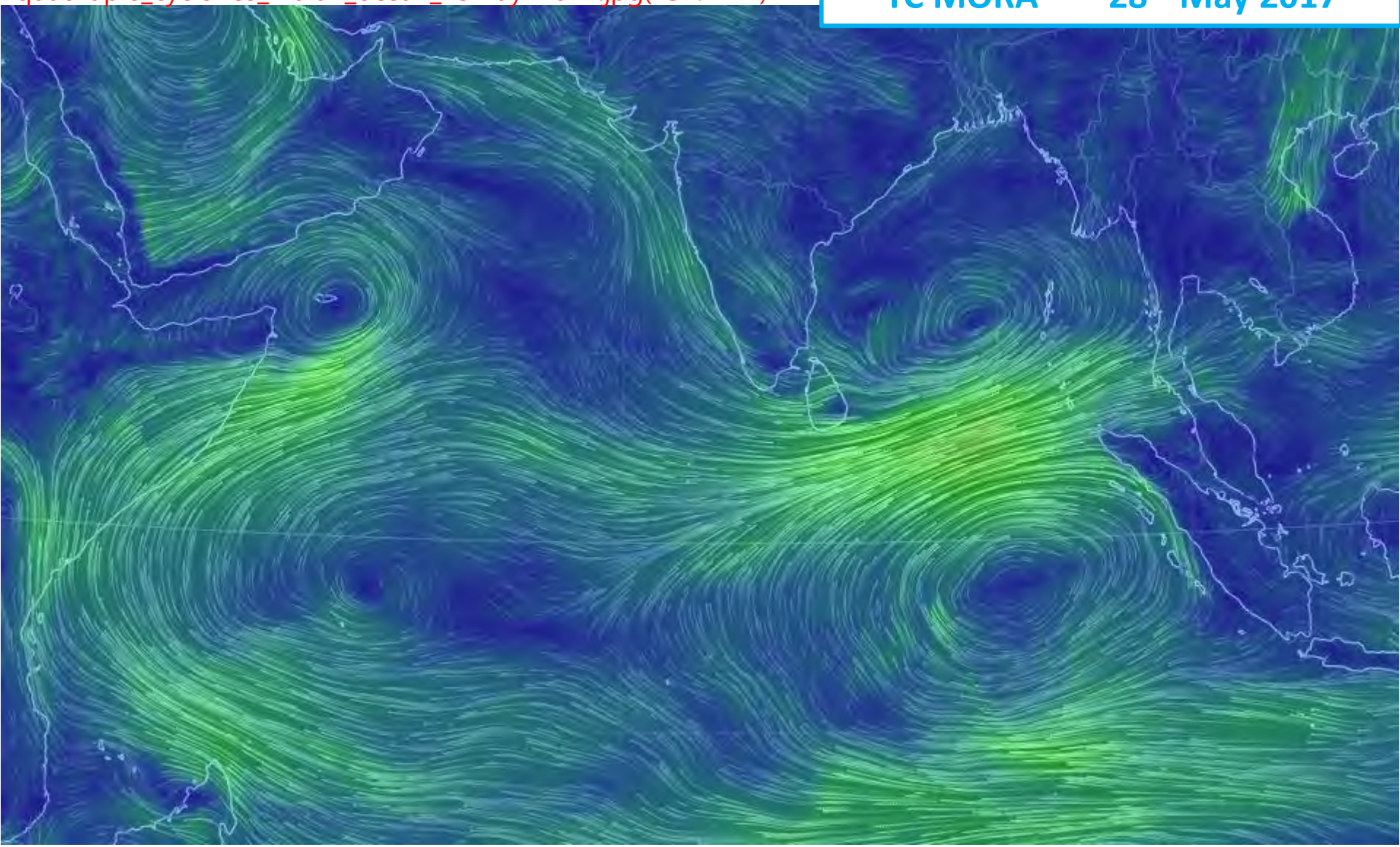
Can BSISO forecast give some information on early detection for typhoon formation?

→ ***BSISO-WP TC relationship***

: Focused on the ***TC related variables*** (e.g. Nolan et al., 2007; Camargo et al., 2000)

Absolute vorticity at 850 hPa, relative humidity at 700 hPa, maximum potential intensity, vertical shear between 850 and 200 hPa, Genesis Potential Index

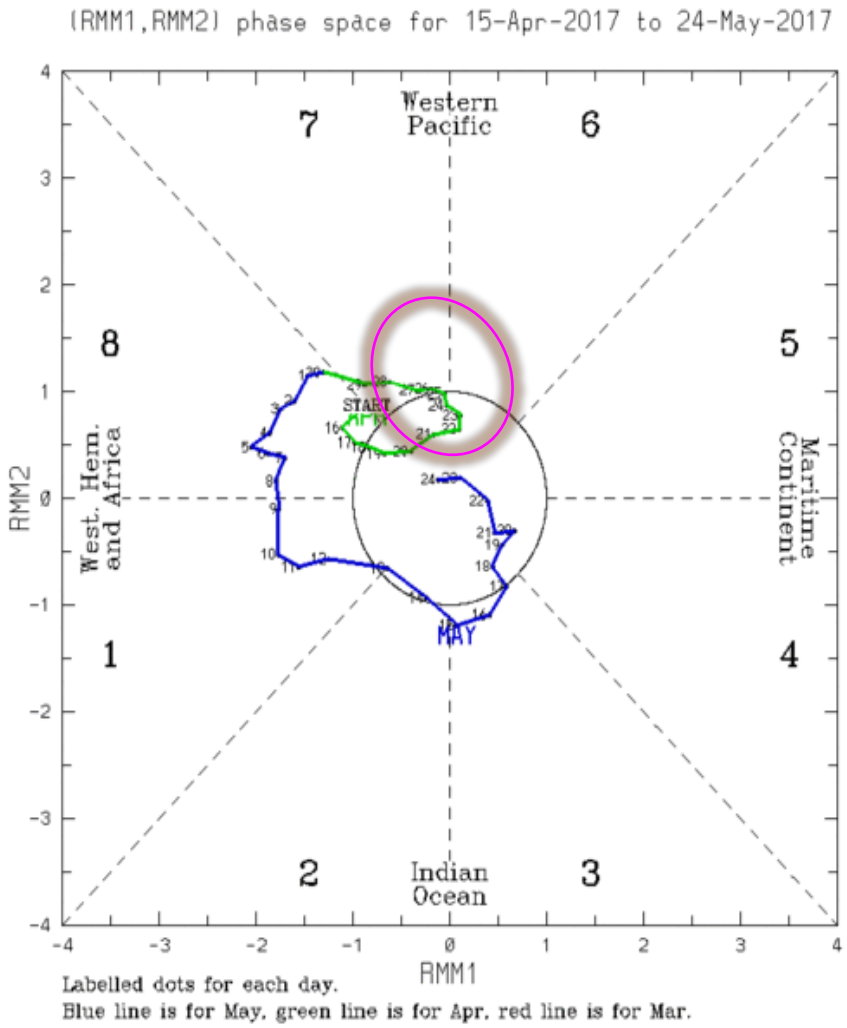
quadruple_cyclones_indian_ocean_25may22017.jpg(132.1 KB)

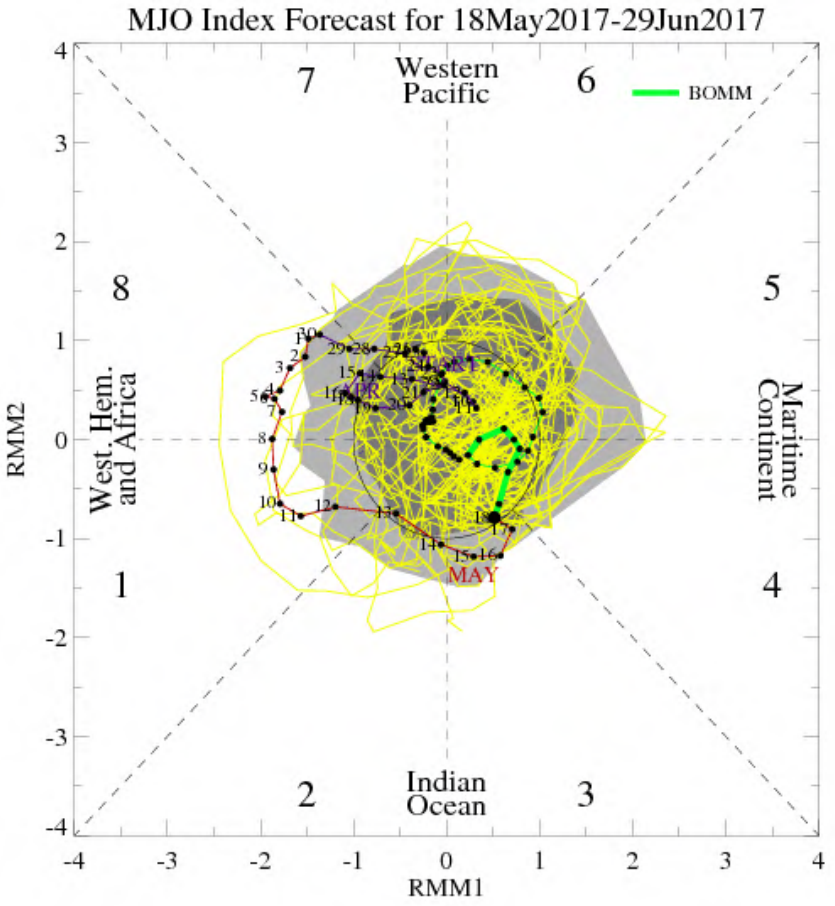


Here is an interesting cyclonic formation in the Indian Ocean (see the attached image). One each in the Arabian Sea and Bay of Bengal and two more just south of the equator. Are they all interconnected? Any comments on this particular formation? I see that there are some studies on cross-equatorial twin cyclones, where each cyclone impact the growth and track of the other cyclone.
Here is one study: http://onlinelibrary.wiley.com/doi/10.1029/2000JD000066/full
Regards, Roxy

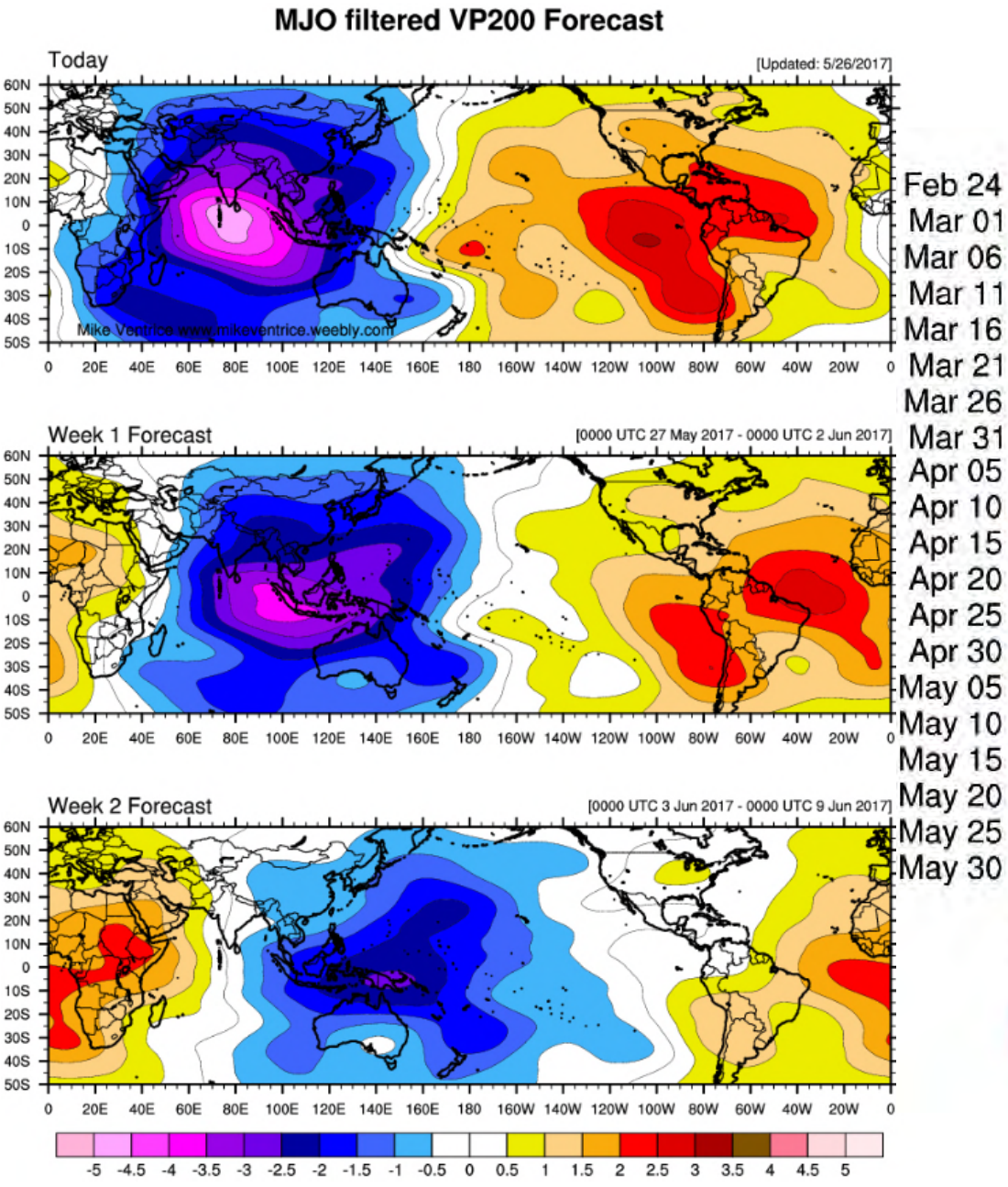
Application Possibility : Typhoon

BSISO-TC activity relationship

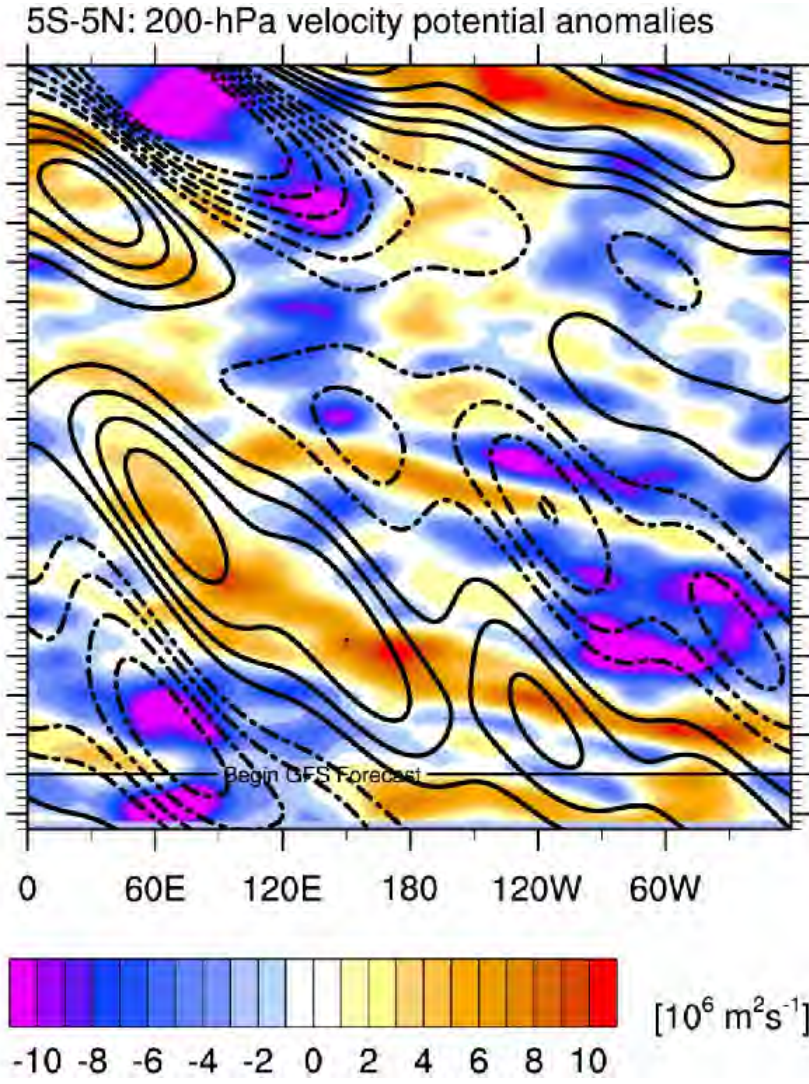




TC MORA 28th May 2017



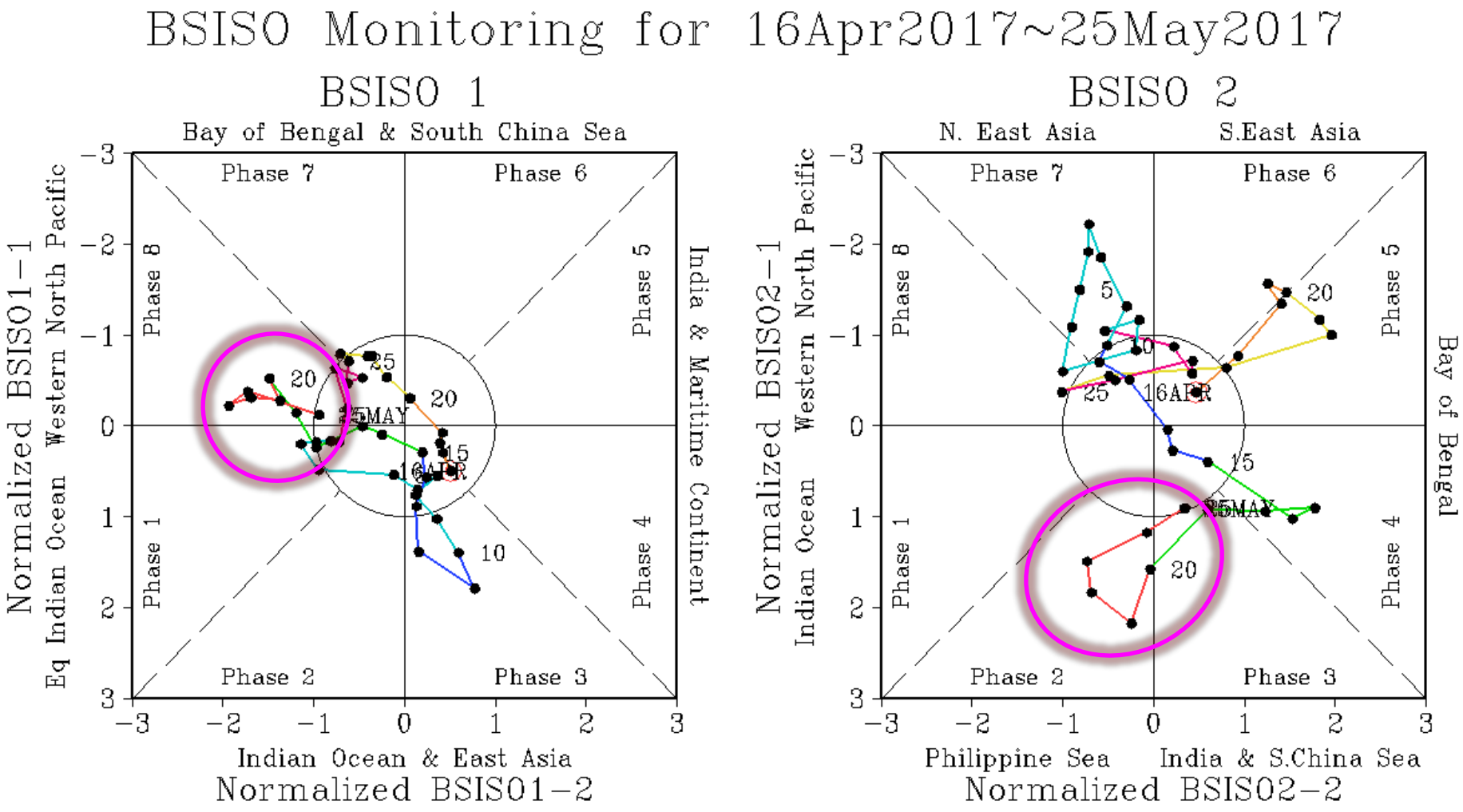
Feb 24
Mar 01
Mar 06
Mar 11
Mar 16
Mar 21
Mar 26
Mar 31
Apr 05
Apr 10
Apr 15
Apr 20
Apr 25
Apr 30
May 05
May 10
May 15
May 20
May 25
May 30



http://www.atmos.albany.edu/student/ventrice/real_time/twc_globe_mjo_vp200.png

Application Possibility : Typhoon

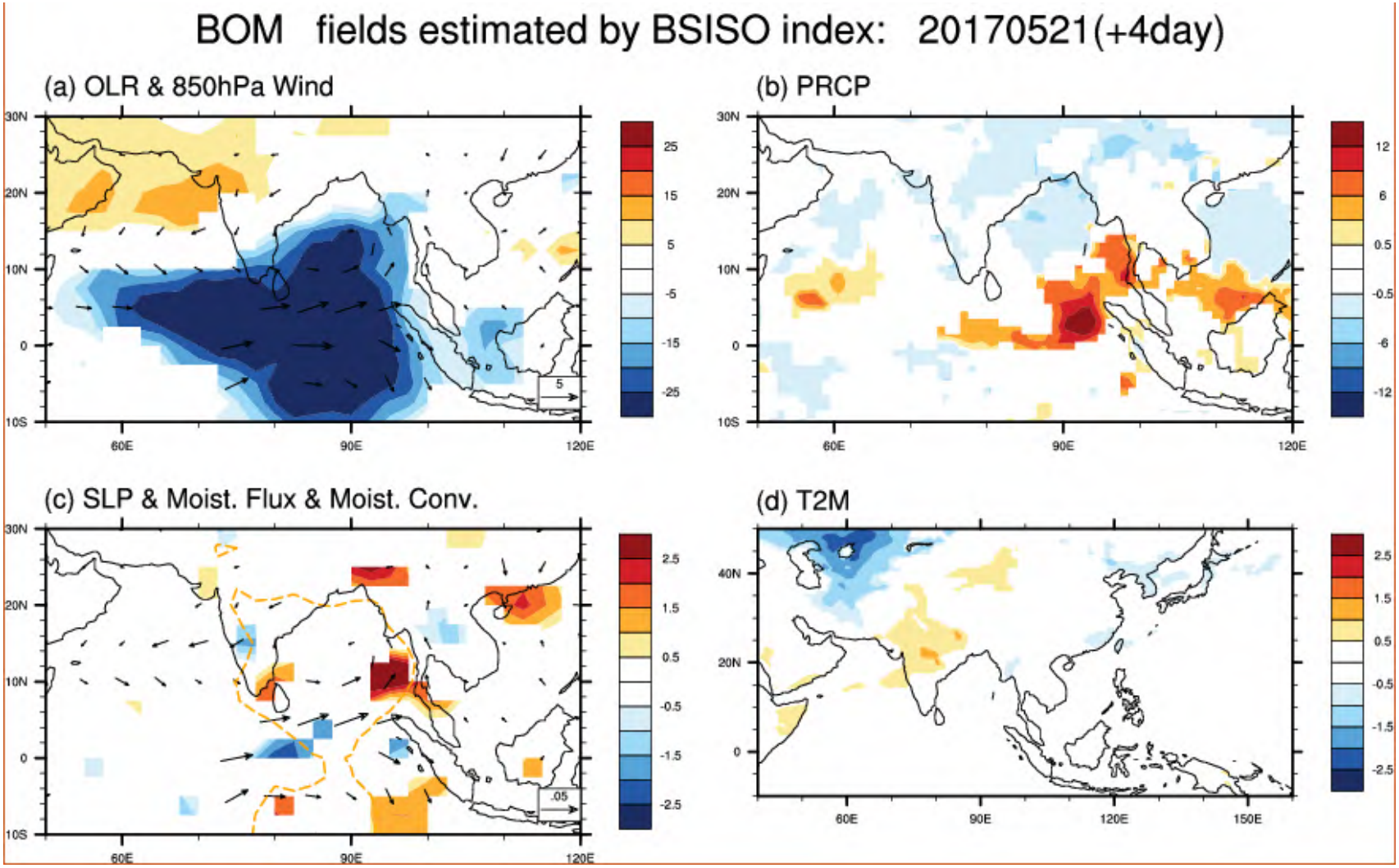
BSISO-TC activity relationship



© APEC Climate Center

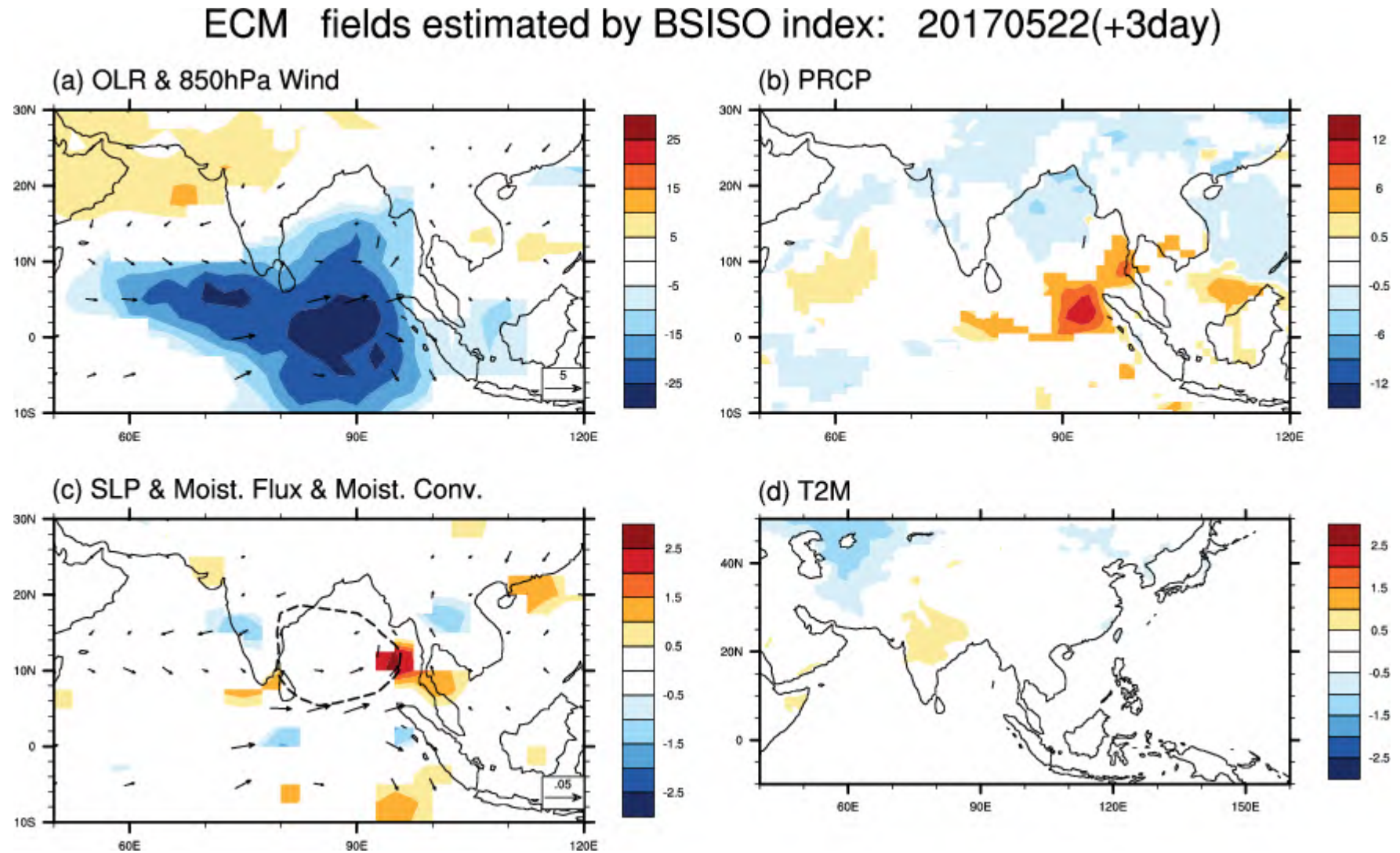
Application Possibility : Typhoon

BSISO-TC activity relationship



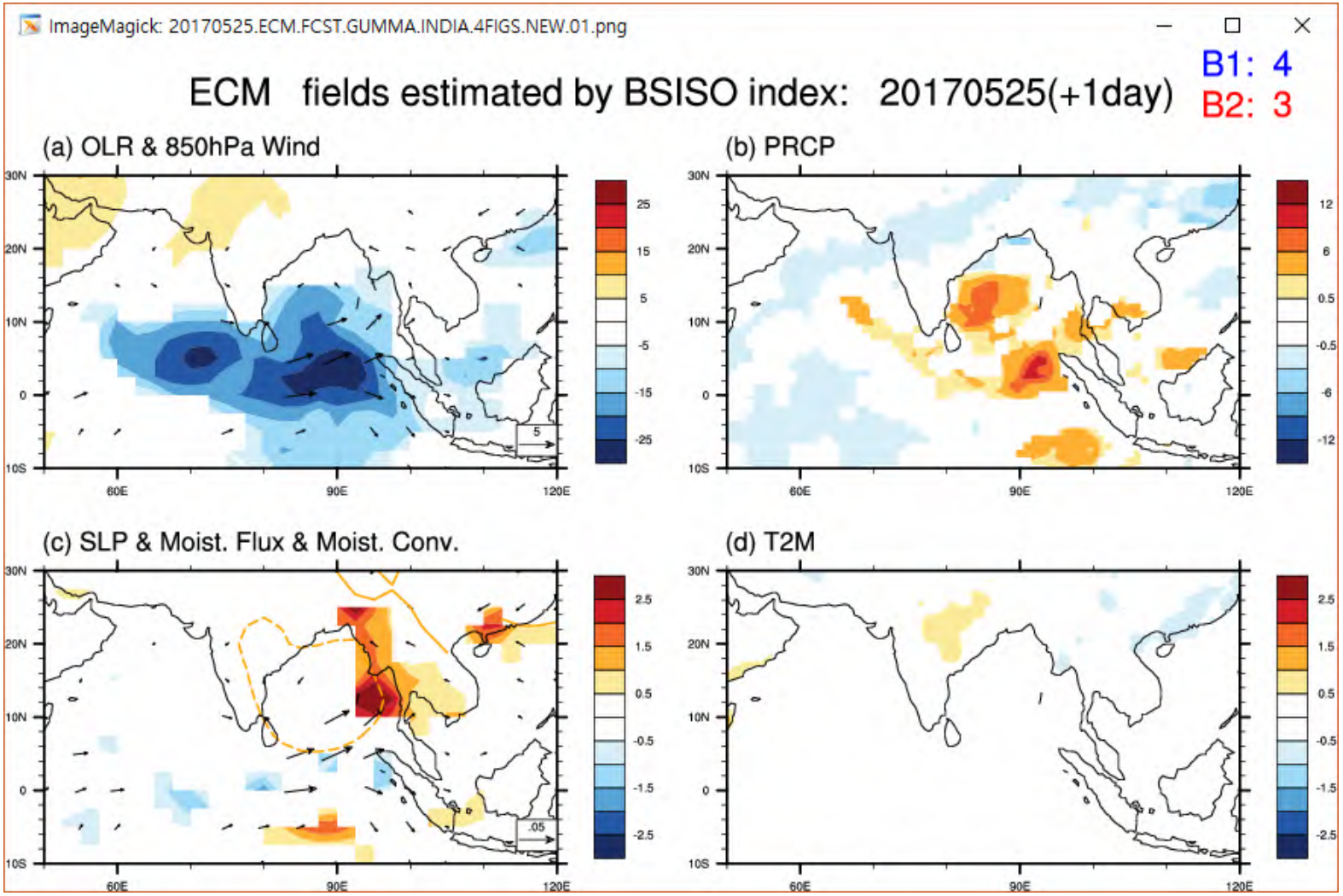
Application Possibility : Typhoon

BSISO-TC activity relationship



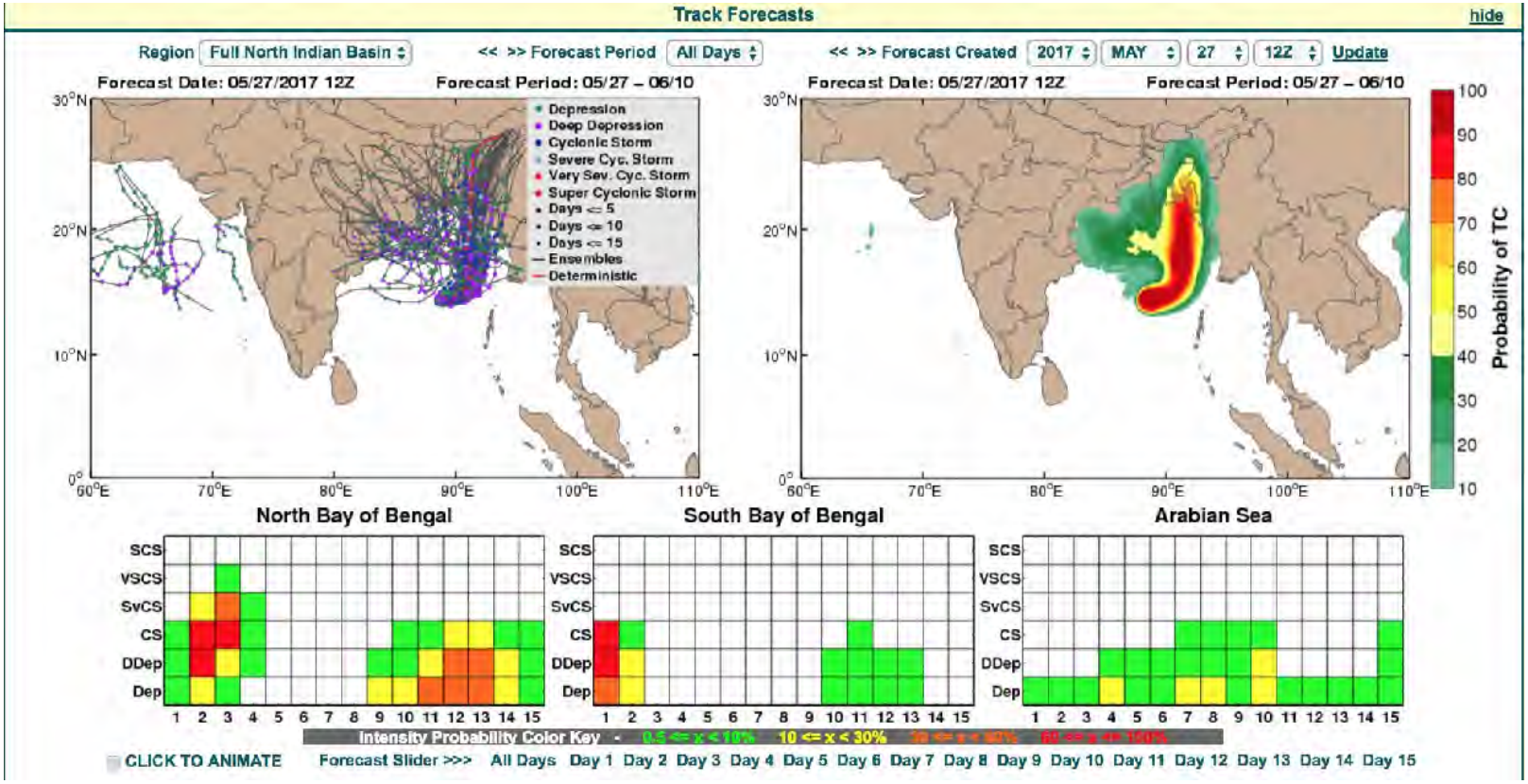
Application Possibility : Typhoon

BSISO-TC activity relationship



TC MORA 28th May 2017

Roxy
I am jumping in to discussion rather late. What you have shown is cyclonic circulations and not the cyclonic formation. These do not have vertical continuity in the vorticity field. These are not seen on the next days chart also. Such cyclonic circulations are seen to present every day on the Indian land area at lower and middle troposphere. These are formed by conversion of shear vorticity into curvature vorticity and from energetic's point of view Kz to Ke conversion. Sometimes these are formed due to meeting of winds from two directions which produces convergence and voricity. These do not have vertical structure like lows , depressions. Their lifetime is also small (one day). They do not travel much.
jrk



Hi All,
Please see below the CFAN forecast for eminent TC approaching Bangladesh.. Surprisingly, no warnings from IMD, BMD, Bangladesh FFWC or RIMES. This is alarming (and disappointing) given that the CFAN EC-based forecast suggests a severe TC landfalling within 3 days!.
I will keep you posted. PW

TC MORA 28th May 2017

India Meteorological Department
Earth System Science Organisation
(Ministry of Earth Sciences)

BULLETIN NO.: 01 (BOB 02/2017)

TIME OF ISSUE: 0900 HOURS IST DATED: 28.05.2017

FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)

TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)
CONTROL ROOM NDMA (FAX.NO. 26701729)
CABINET SECRETARIAT (FAX.NO.23793144)
PS TO HON'BLE MINISTER FOR S& T AND EARTH SCIENCES (FAX NO.23316745)
SECRETARY, MOES, (FAX NO. 24629777)
SECRETARY, DST (FAX NO. 26863847/-2418)
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)
DIRECTOR GENERAL, DOORDARSHAN (23385843)
DIRECTOR GENERAL, AIR (25843825)
PIB MOES (FAX NO. 23389042)
UNI (FAX NO. 23355841)
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912)
CHIEF SECRETARY, GOVT.OF WEST BENGAL (033-22144328)
CHIEF SECRETARY, GOVT.OF TRIPURA (0381-2414013)
CHIEF SECRETARY, GOVT.OF MANIPUR (0385-2452629, 0385-2451144)
CHIEF SECRETARY, GOVT.OF MIZORAM (0389-2322745, 0389-2314627)
CHIEF SECRETARY, ANDAMAN & NICOBAR ISLANDS (FAX No. 03192-223331)

Sub: Depression over Central Bay of Bengal

Latest observations & satellite imagery indicate that a depression has formed over central Bay of Bengal and lay centred at 0530 hrs IST of today, the 28th May, 2017 near Latitude 14.0° N and Longitude 88.5 °E, about 950 km south of Kolkata and 980 km south-southwest of Chittagong. The system is very likely to move north-northeastwards and reach Bangladesh coast by 30th May 2017 forenoon. It is very likely to intensify into a deep depression during next 24 hours.

Warning:

(i) **Wind warning:** Squally winds speed reaching 40-50 kmph gusting to 60 kmph would prevail along & off Andaman Islands and adjoining Sea areas during next 48 hours.

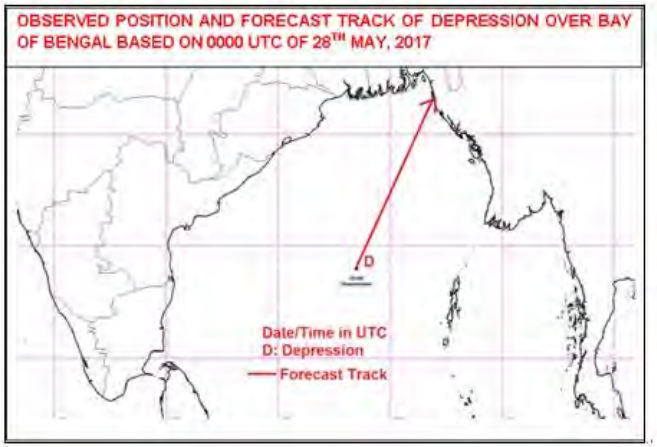
(ii) **Sea condition:** Sea condition would be rough to very rough along & off Andaman Islands during next 48 hours.

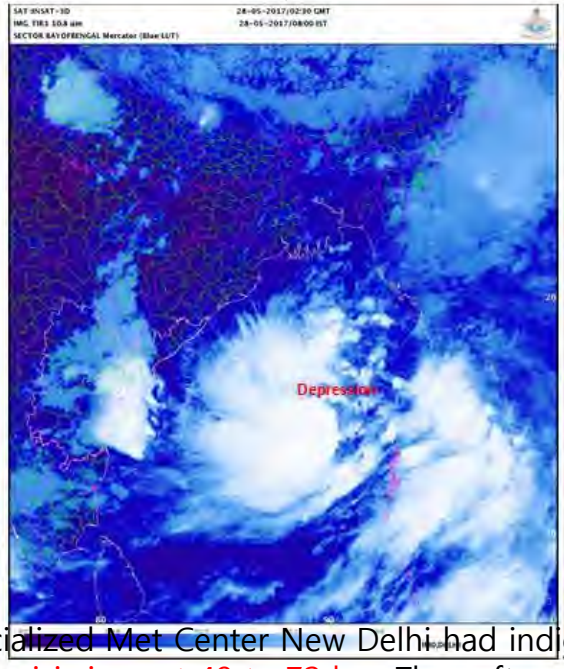
(iii) **Fishermen Warning:** Fishermen are advised not to venture into sea along & off Andaman Islands during next 48 hrs. Fishermen out at sea are advised to return to the coast.

The next bulletin will be issued at 1130 hrs IST of 28th May 2016.

(Naresh Kumar)
Scientist-D
RSMC, New Delhi

Copy to: DFDD, Pune/ACWC Kolkata /ACWC Chennai/CWC Vishakhapatnam/CWC Bhubaneswar/MC Hyderabad

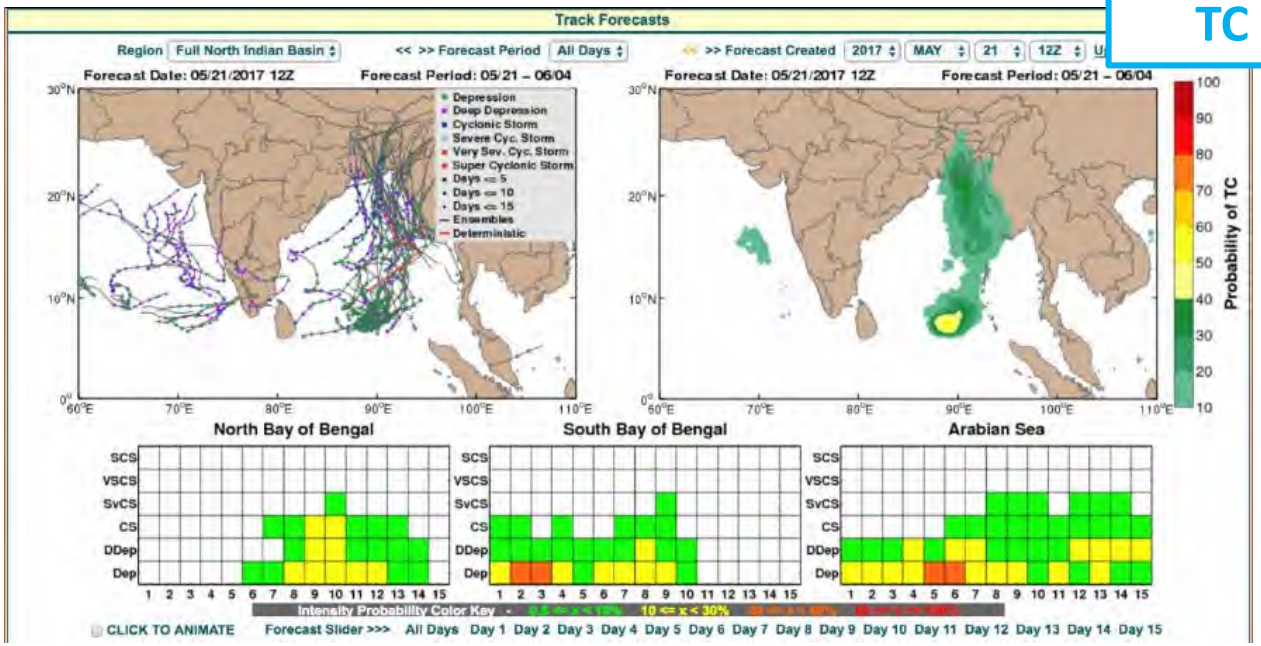


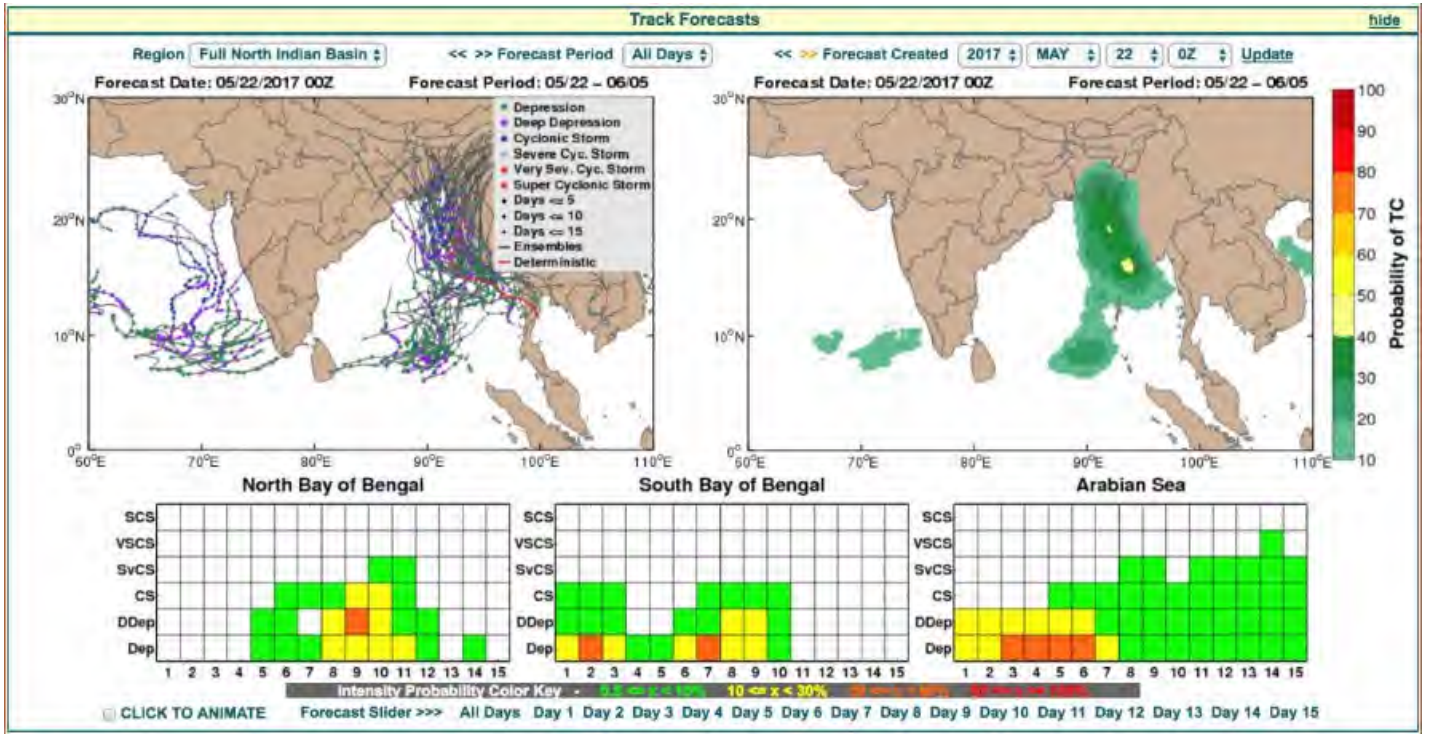


Dear All,

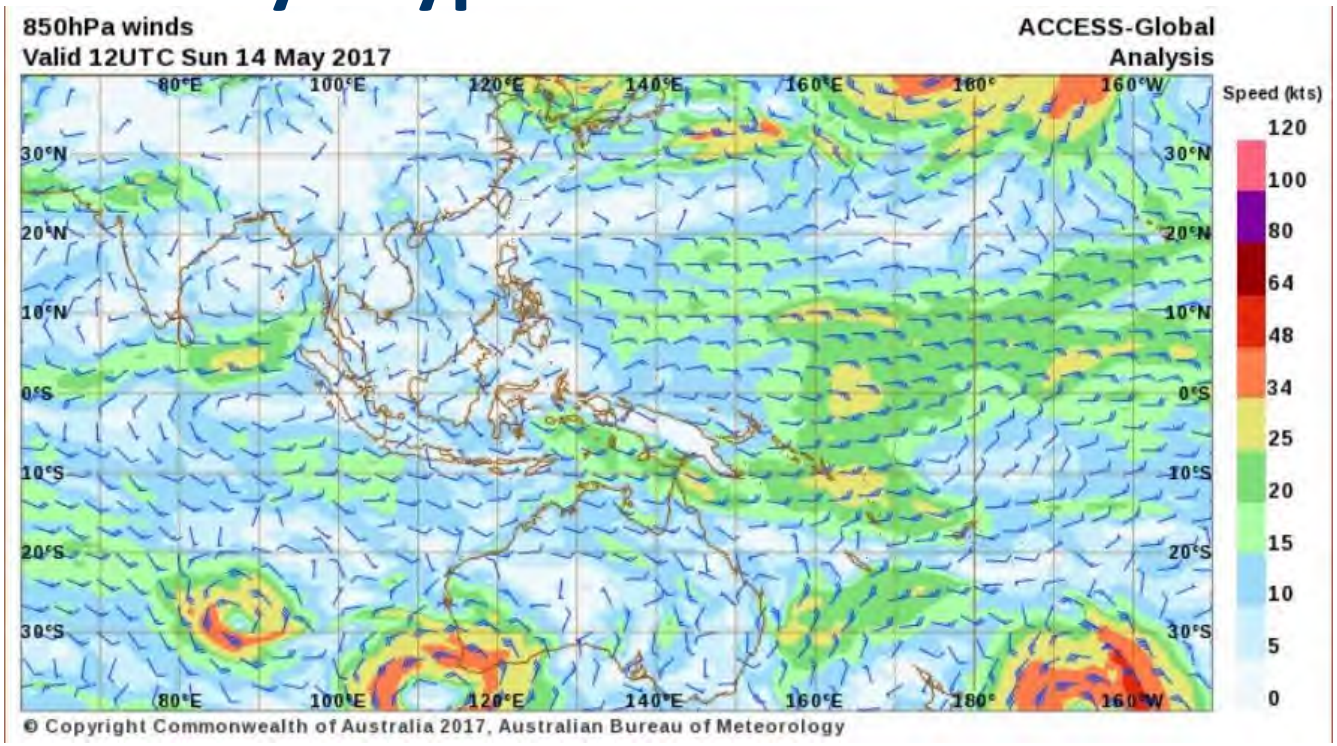
Related to this I would like to bring to your notice that IMD/Regional Specialized Met Center New Delhi had indicated in their morning Bulletin of 26th May with 51% to 75% probability of cyclogenisis in next 48 to 72 hrs. Thereafter regular bulletins are being issued with raising probability to 76% to 100% on 27th morning. Latest Bulletin is copied below. You may refer website www.rsmcnewdelhi.imd.gov.in for updates.
Sharing forecasts/warnings are most welcome. Let us all work towards safer world by providing timely warnings.
WIth best wishes, Ajit Tyagi

TC MORA 28th May 2017





Application Possibility : Typhoon



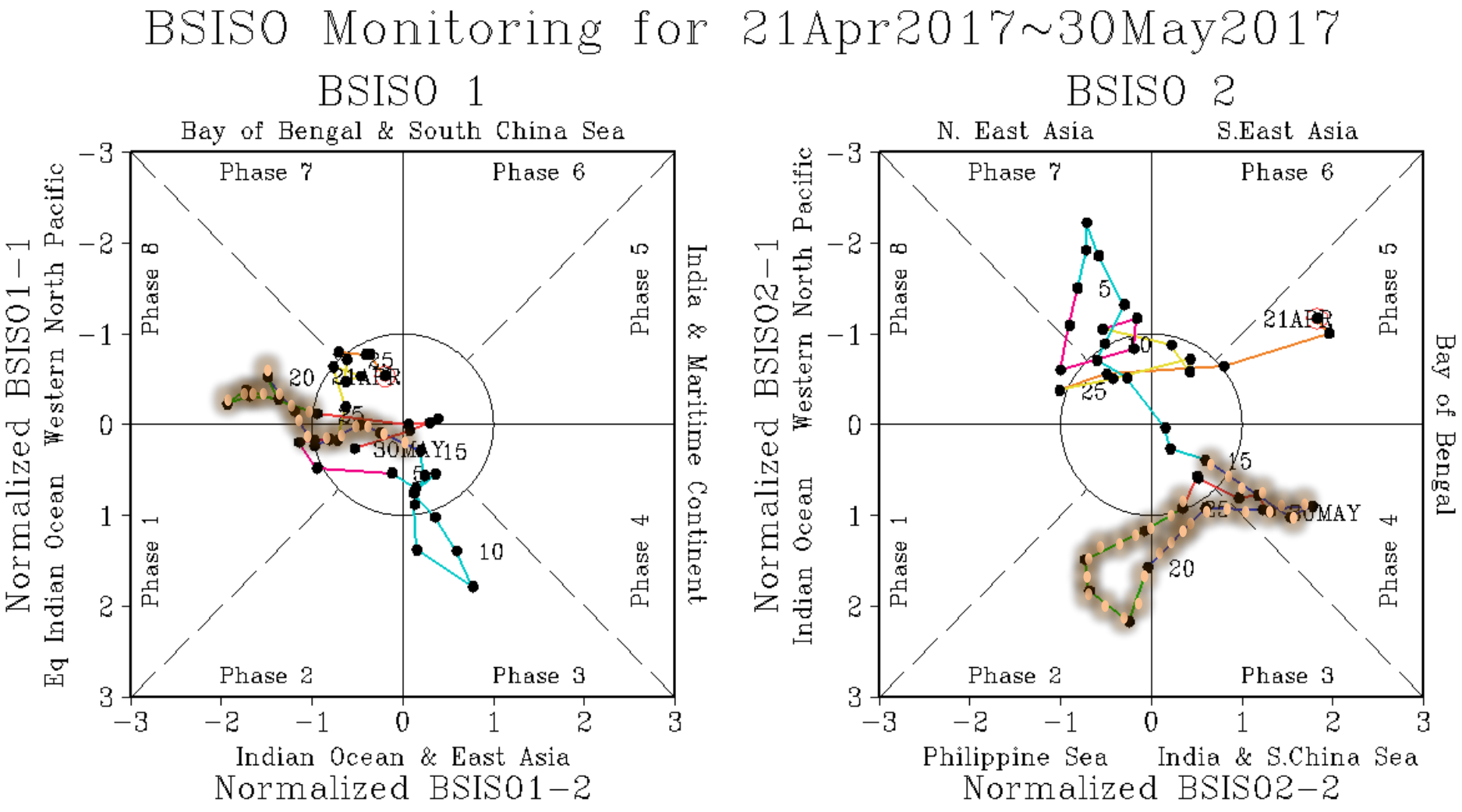
Hi,
The 850hPa wind jet in the equatorial Indian Ocean:
This low level wind jet in the Indian Ocean has been there, almost stationary, for two weeks now.
To illustrate I have attached three 850hPa analyses from 12UTC on 14 May, 24 May and 29 May.
This jet was the main synoptic feature associated with the very heavy rainfall on the South and Southwest coasts of Siri Lanka around 24-25 May, which led to the devastating flooding and loss of life.
In addition, it was the central westerly as part of the structure of the twin cyclones, one of which became tropical storm Mora.
The twin cyclones have been discussed a bit already, and as pointed out they have the dynamical structure of an n=1 Rossby Wave. Still, to me its mysterious. What has maintained this feature for so long? Why stationary? (Rossby wave embedded in a background westerly flow?).
What effect has such a sustained wind had on the underlying ocean?
Any dynamical insights out there?
I'll get out of your way
John McB

Peter

Thanks for sharing CFAN forecasting - it is rather surprising why there is no forecast from the regional met services. Any ideas of recent floods in Sri Lanka - every monsoon is so different and intriguing...and keeps us busy
http://www.bbc.com/news/world-asia-40070660
-Anna

BSISO condition for 14May ~ 25May

TC MORA 28th May 2017



© APEC Climate Center

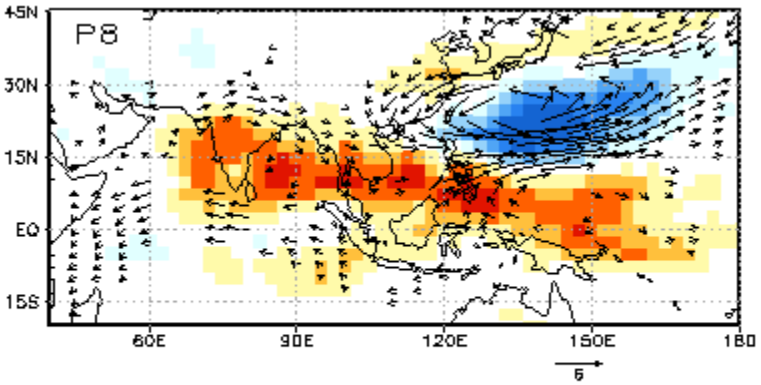
B1 is active in Phase 8

B2 is active in Phase 4-3-2

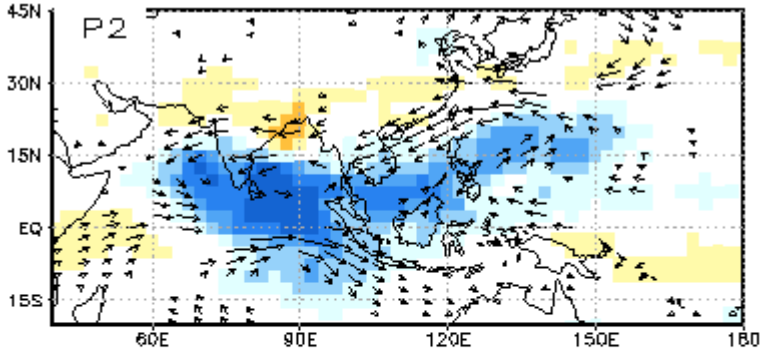
Application Possibility : Typhoon

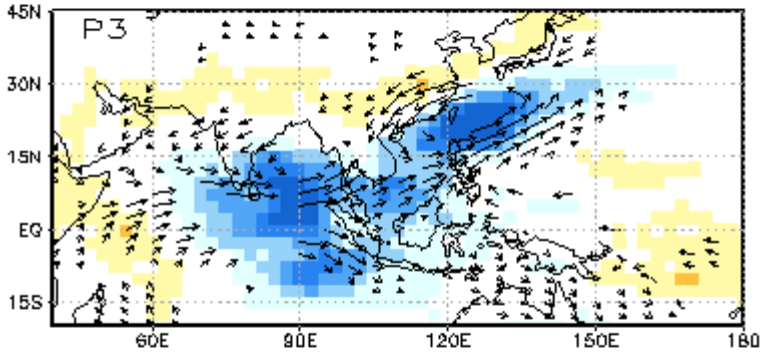
BSISO-TC activity relationship

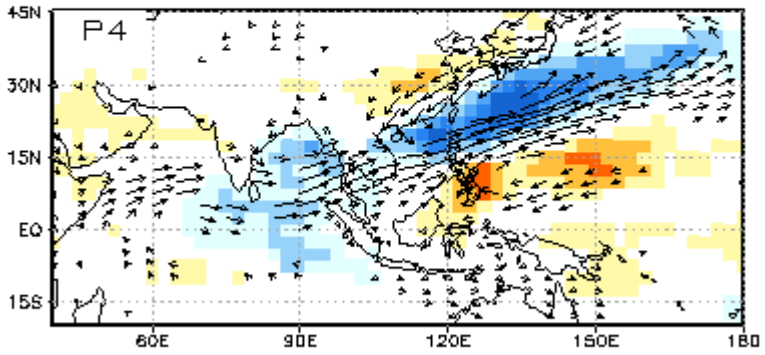
BSISO1



BSISO2







Thought that BSISO2 might contribute to stationary westerlies over the equatorial Indian ocean.

Application Possibility : Typhoon

BSISO-TC activity relationship

Ongoing research

WNP TC

Deterministic forecast (ISGPI)

Probability forecast of TC Occurrence

A new ISGPI for NH summer

$$ISGPI_{MJJASO} = (-0.51)* \omega_{500} + (-0.21)* V_{zs} + (0.20)* f\zeta_{r850}$$

Region	ω_{500}	V_{zs}	$f\zeta_{r850}$	Equation
Globe	0.68[1]	0.72[2]	0.74[3]	$(-0.51)*\omega_{500} + (0.20)*f\zeta_{r850} + (-0.21)*V_{zs}$
IO	0.72[1]	0.79[3]	0.78[2]	$(-0.56)*\omega_{500} + (0.32)*f\zeta_{r850} + (-0.12)*V_{zs}$
WNP	0.75[1]	0.78[2]	0.80[3]	$(-0.55)*\omega_{500} + (0.22)*f\zeta_{r850} + (-0.20)*V_{zs}$
ENP	0.81[1]	0.84[3]	0.84[2]	$(-0.67)*\omega_{500} + (0.24)*f\zeta_{r850} + (-0.02)*V_{zs}$
Western NAT	0.49[3]	0.48[2]	0.45[1]	$(-0.16)*\omega_{500} + (0.46)*f\zeta_{r850} + (-0.25)*V_{zs}$

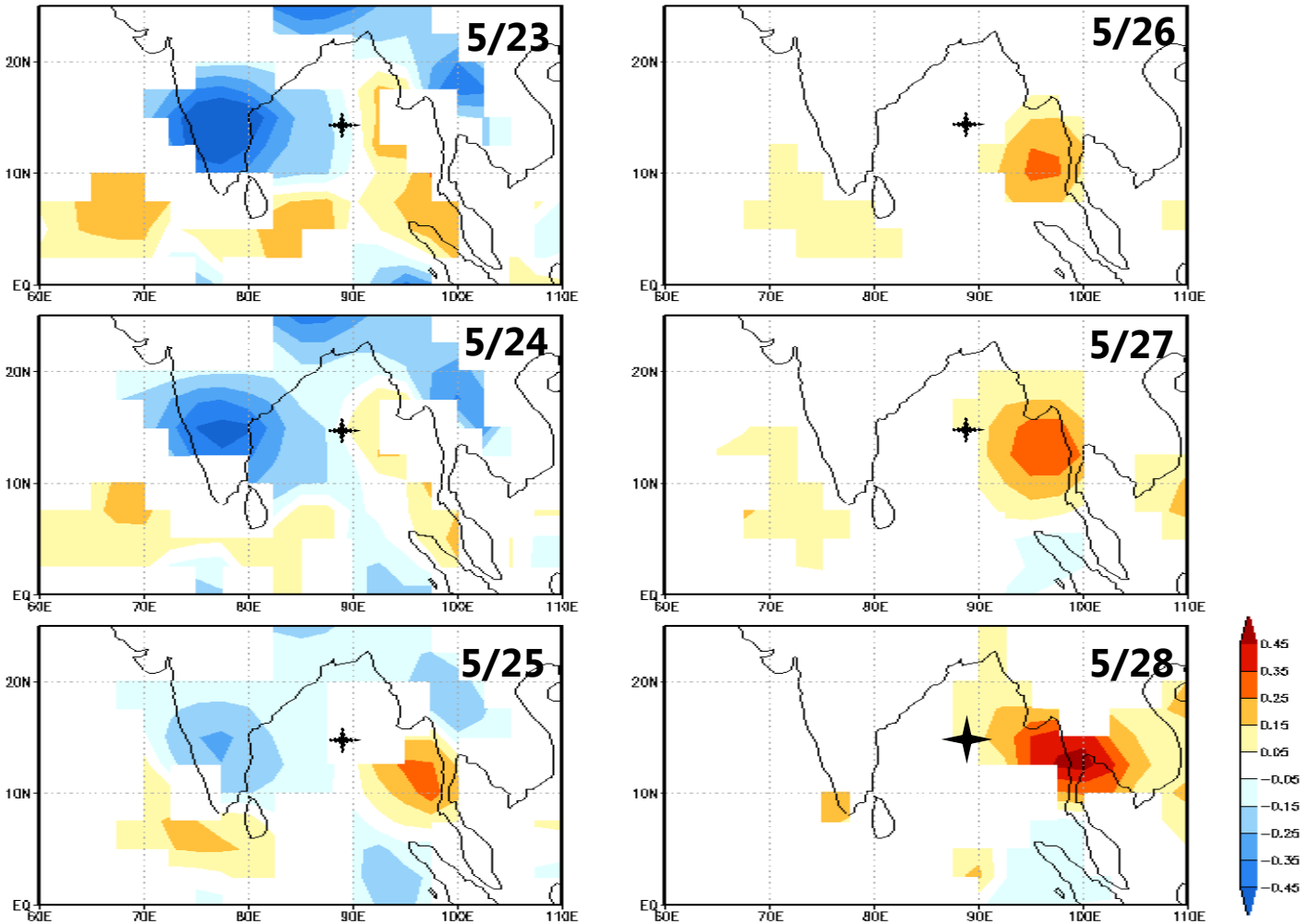
BSISO modulation of tropical cyclone genesis and sub-seasonal prediction - A new intraseasonal GPI for Northern Hemisphere(NH) summer (May-Oct)

[Moon et al., 2017, submitted to J. Climate]

Application Possibility : Typhoon

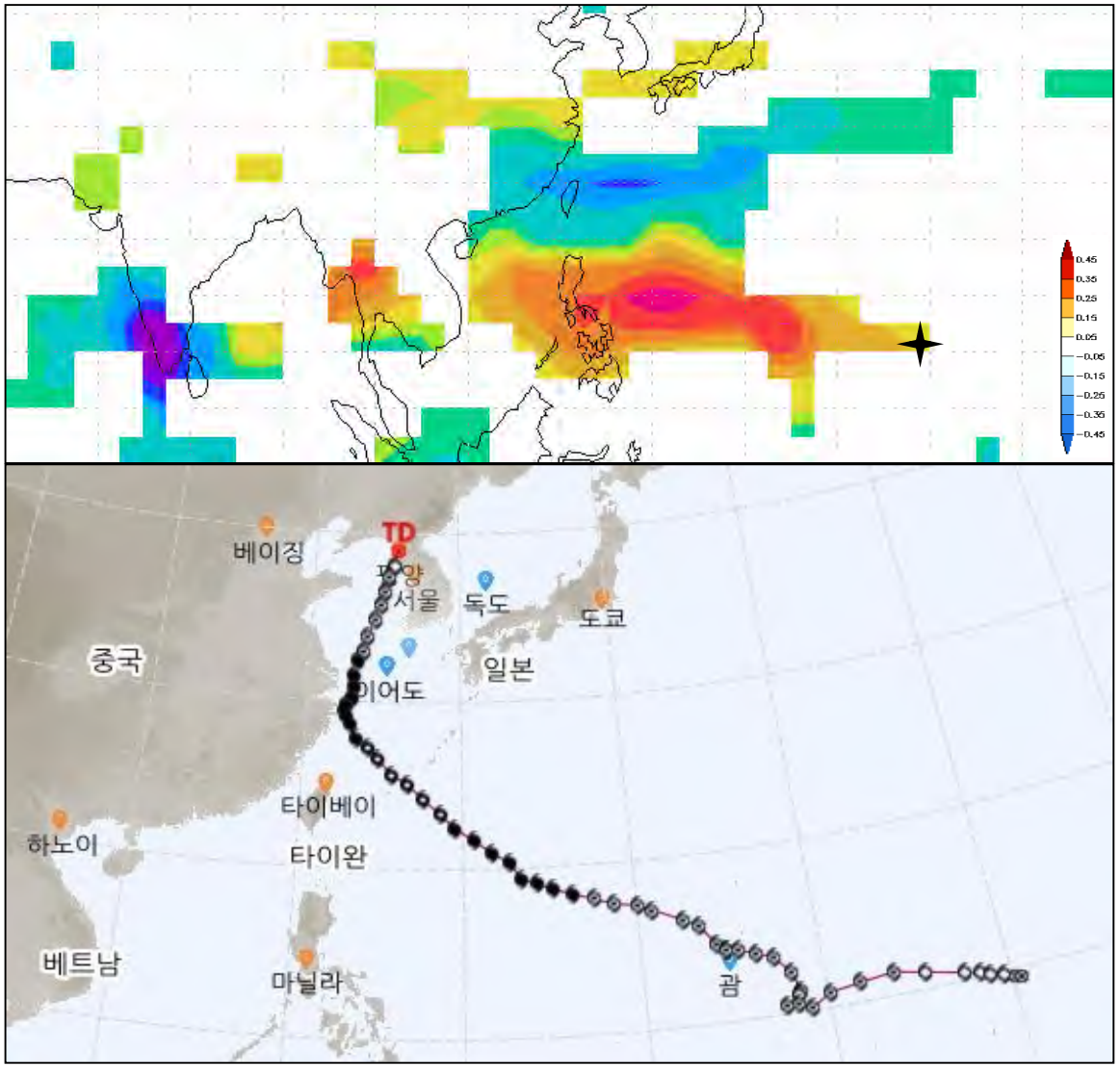
BSISO-TC activity relationship

ISGPI estimated by BSISO indices



Application Possibility : Typhoon

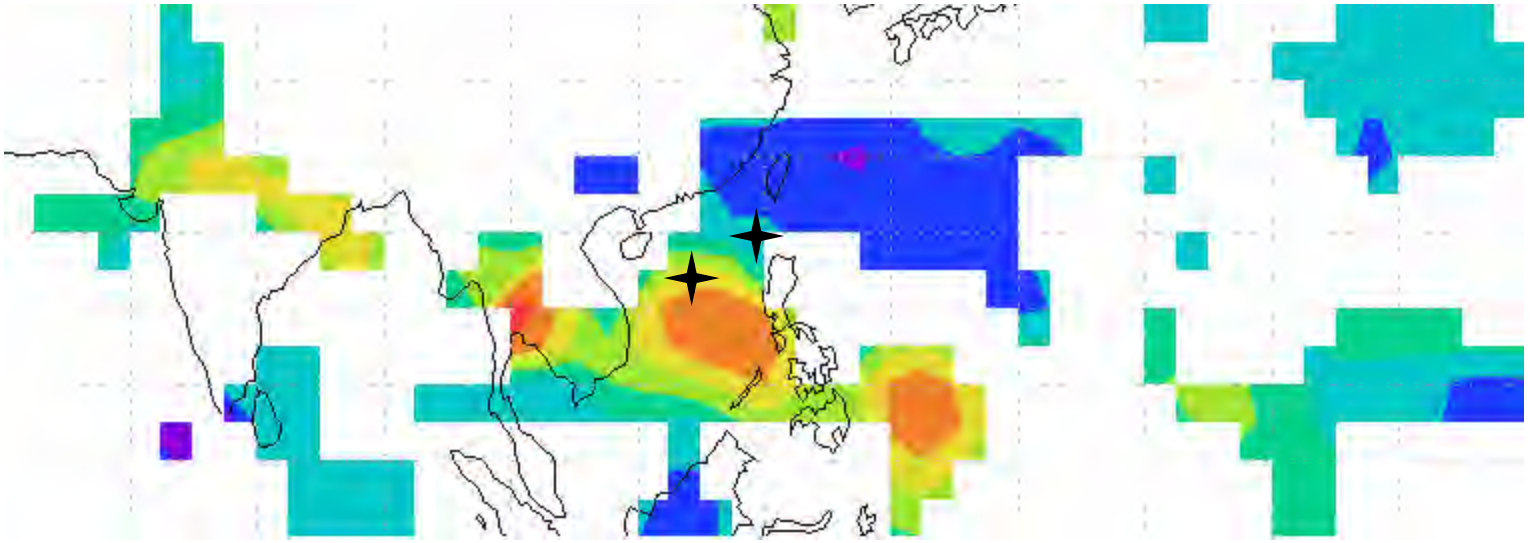
BSISO-TC activity relationship

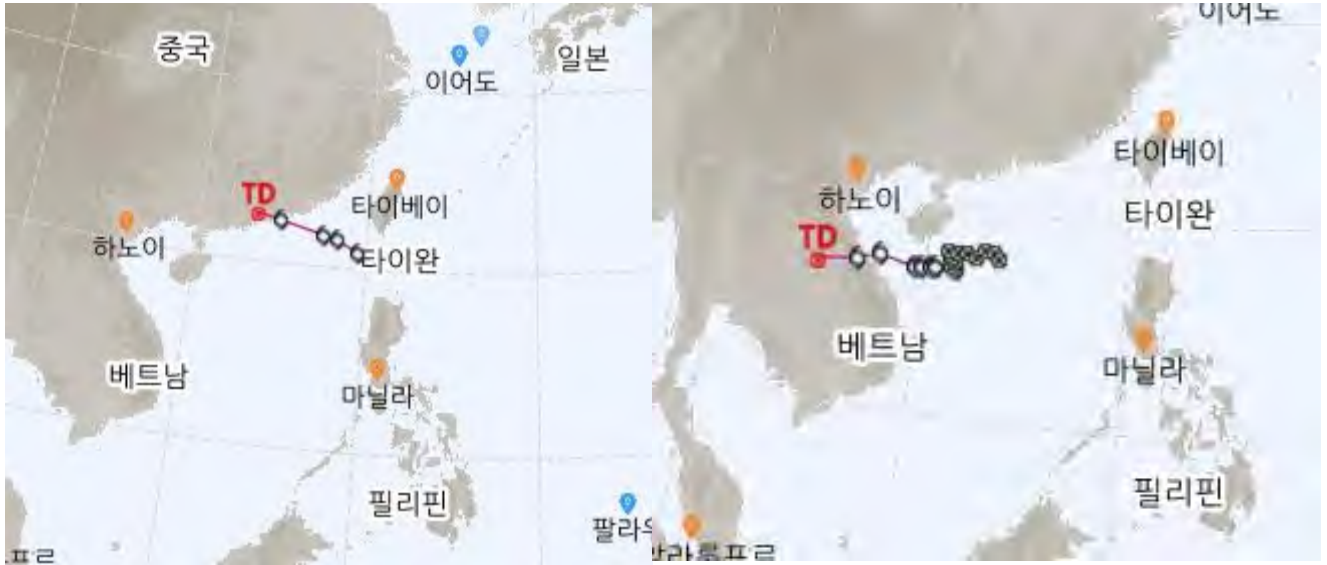


Application Possibility : Typhoon

2017 TC #7 ROKE
2017 TC #8 SONCA

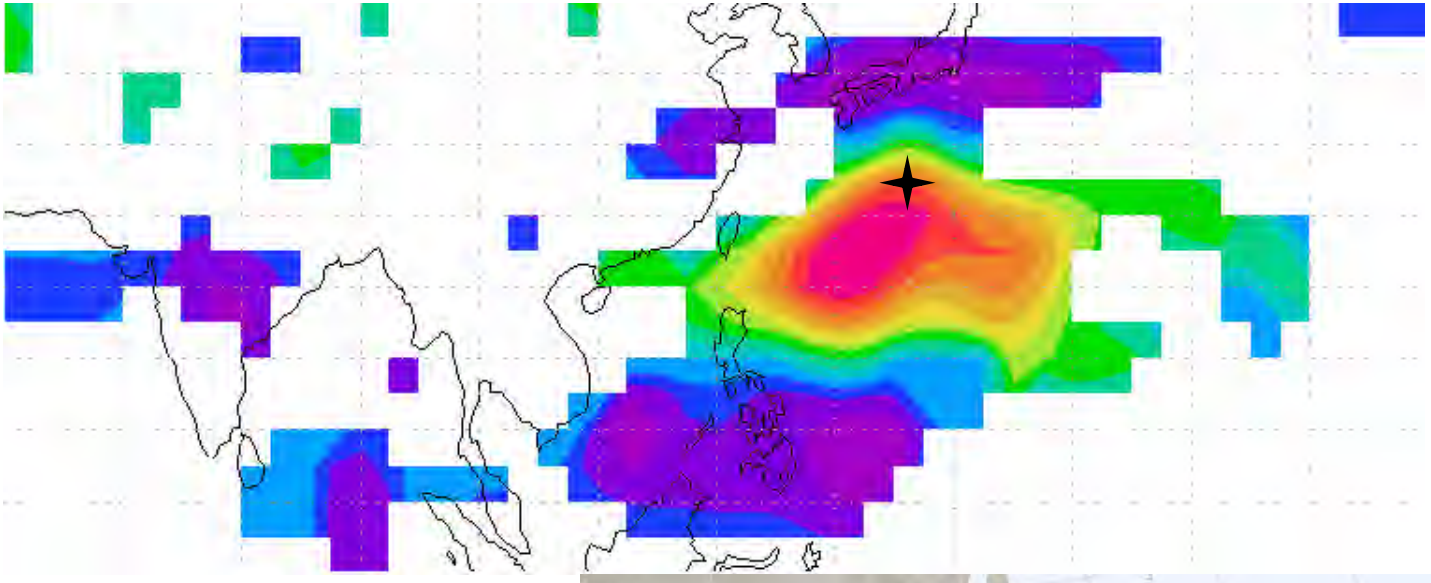
BSISO-TC activity relationship





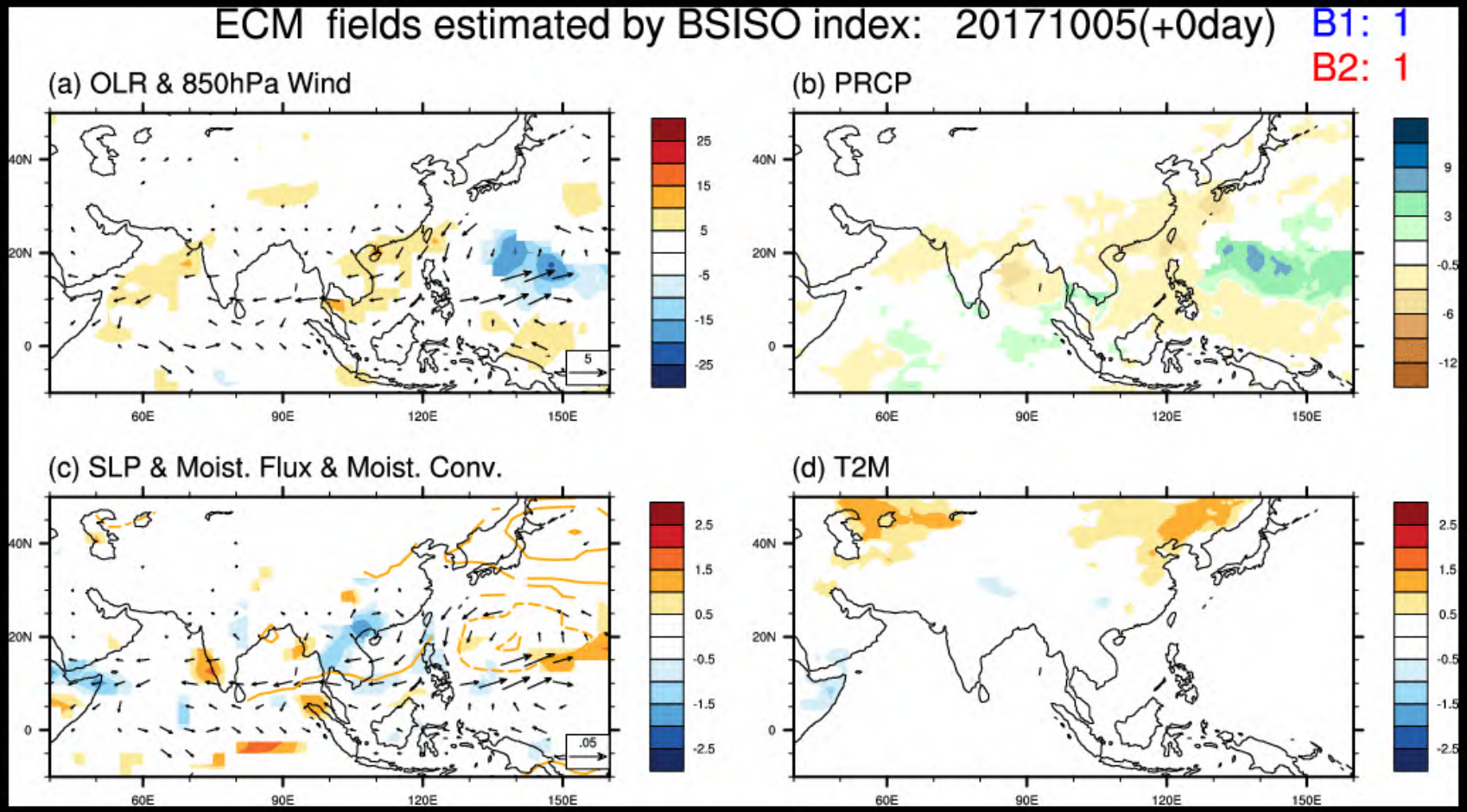
Application Possibility : Typhoon

BSISO-TC activity relationship



20 day forecasts estimated by BSISO forecast

Model : ECMWF

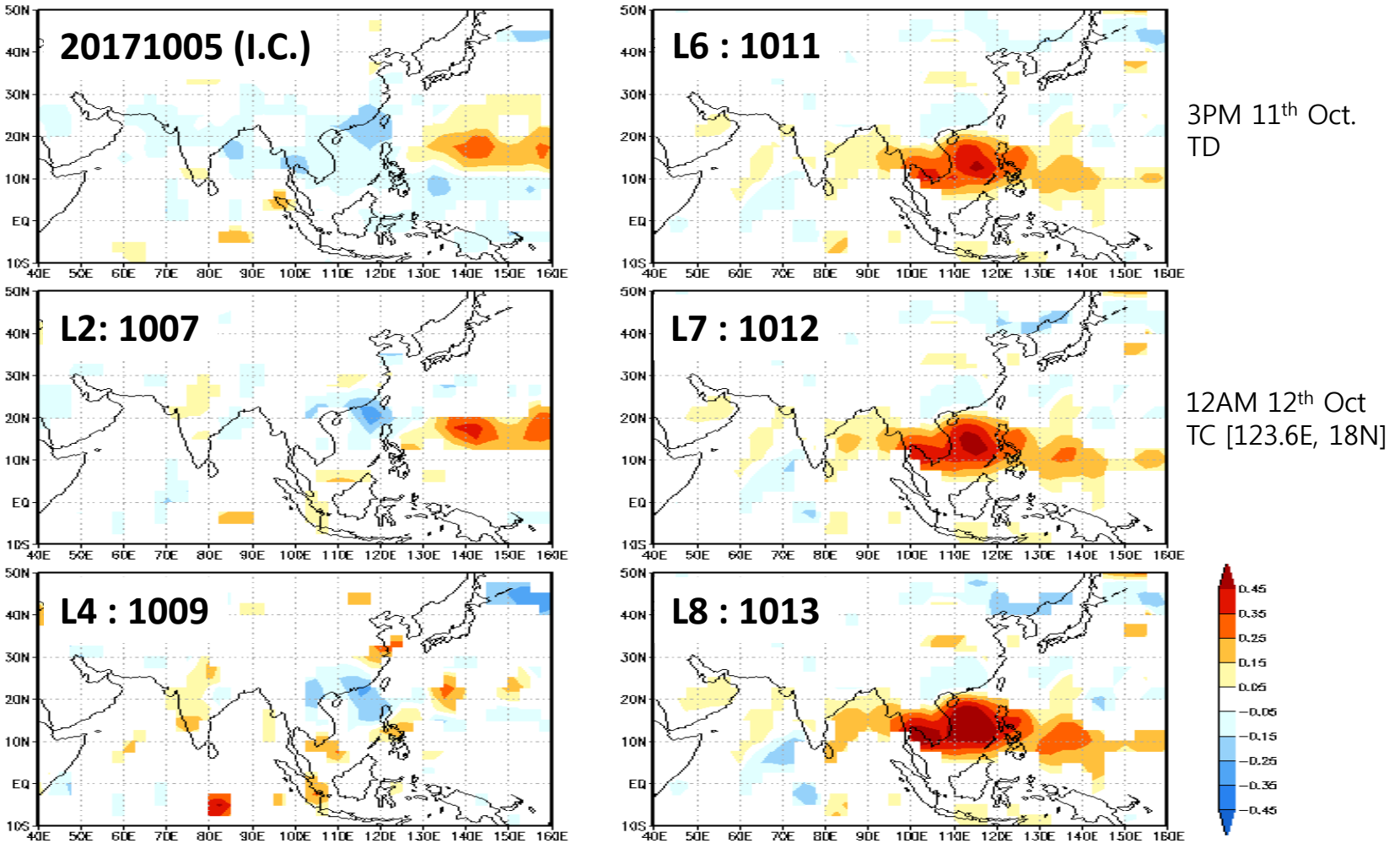


Application Possibility : Typhoon

BSISO-TC activity relationship

ISGPI forecast using BSISO forecast for TC Khanun (20)

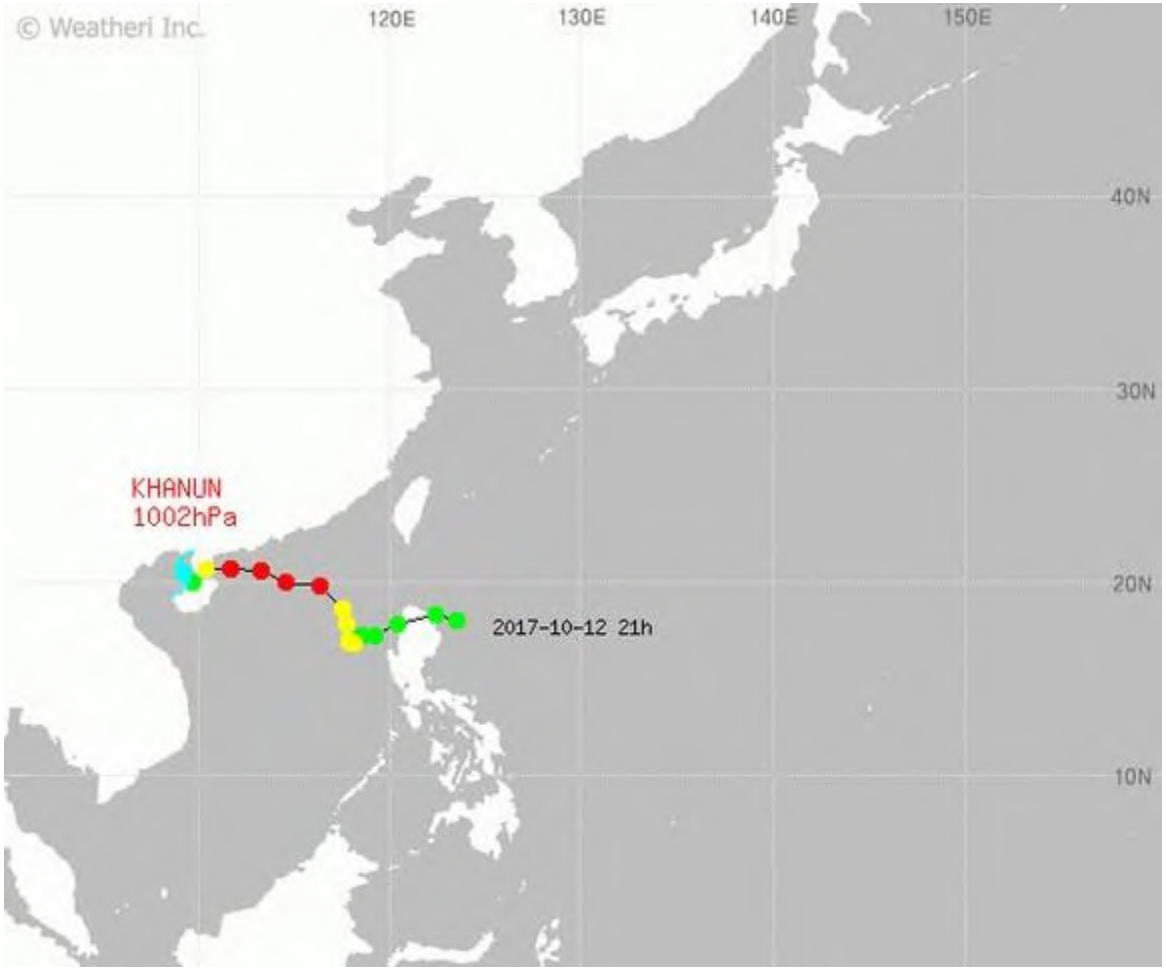
Model : ECMWF



Application Possibility : Typhoon

BSISO-TC activity relationship

TC Khanun (20)

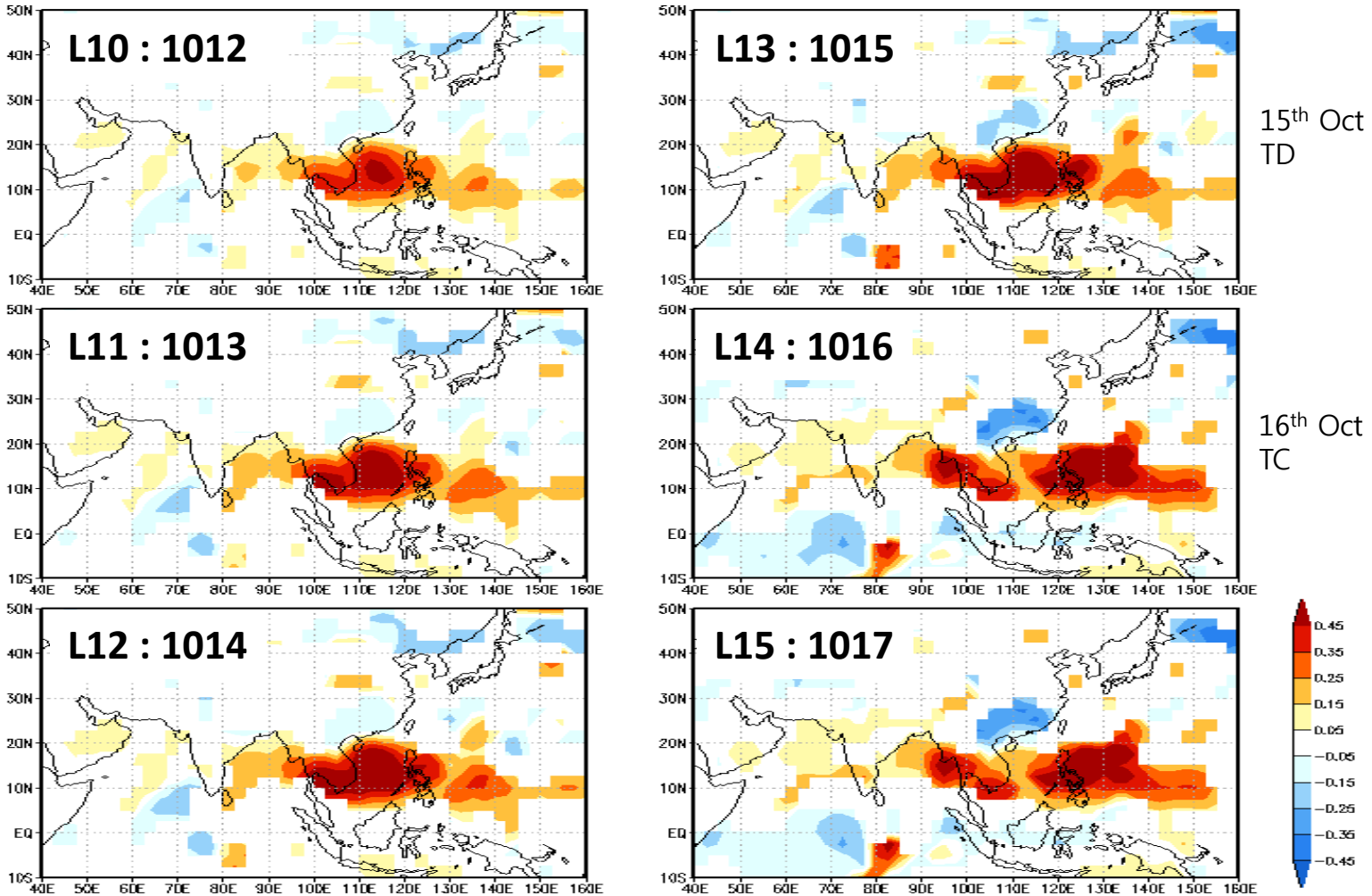


Application Possibility : Typhoon

BSISO-TC activity relationship

ISGPI forecast using BSISO forecast for TC Lan (21)

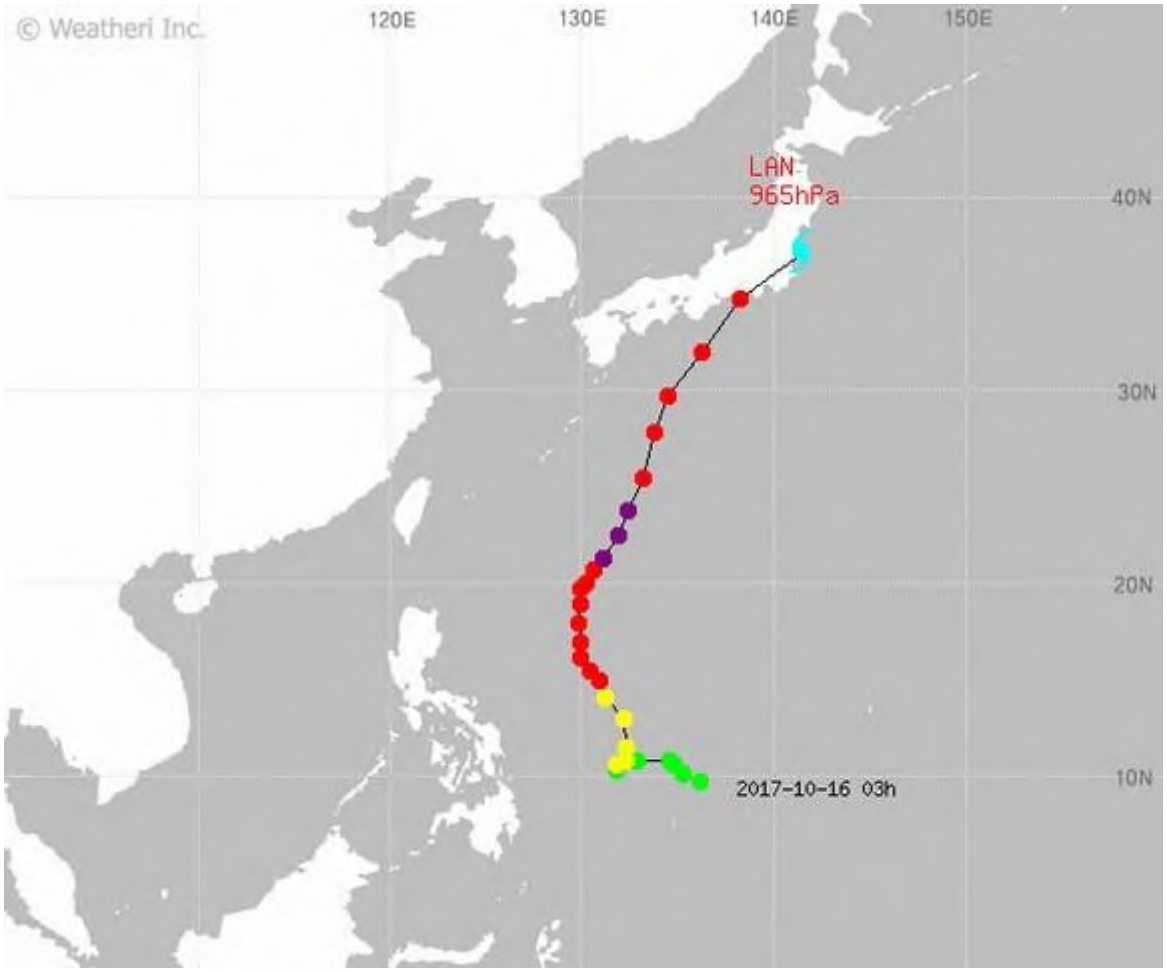
Model : ECMWF



Application Possibility : Typhoon

BSISO-TC activity relationship

TC Lan (21)



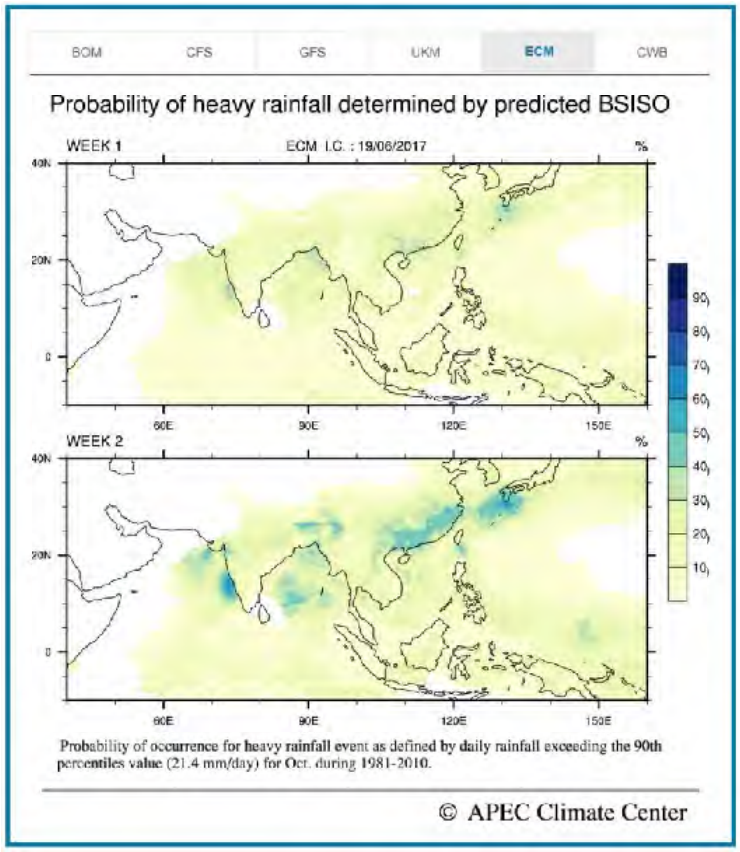
BSISO Forecast

Better forecast from better recognition of the value

Development of a guideline to increase practical use of BSISO forecast

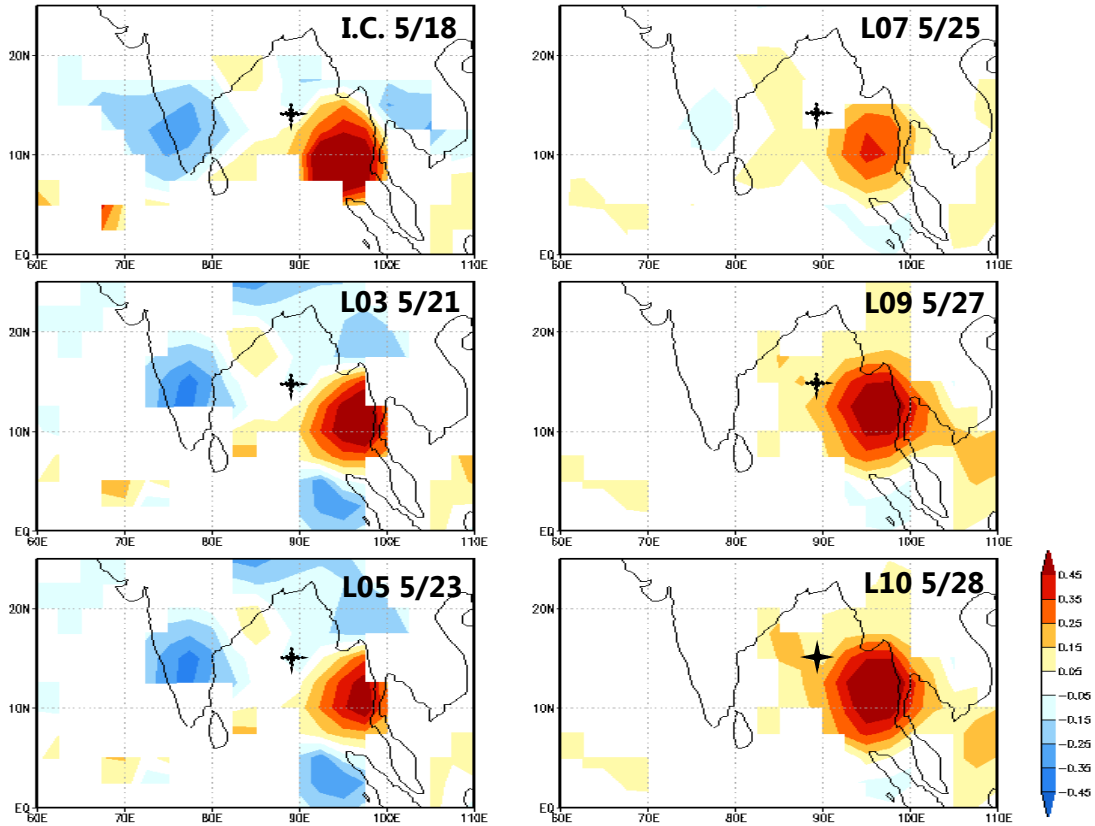
Heavy rainfall forecast based on BSISO index forecast [ECMWF]

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



ISGPI forecast estimated by BSISO index forecast [ECMWF]

❖ Ex> Tropical Cyclone Mora-17, May 28, 2017



Application Possibility

- **BSISO-extreme events relationship**

‘16

’17’18

’17’18

Thank you

Application Possibility : Typhoon

BSISO-TC activity relationship

WNP TC

Deterministic forecast (ISGPI)

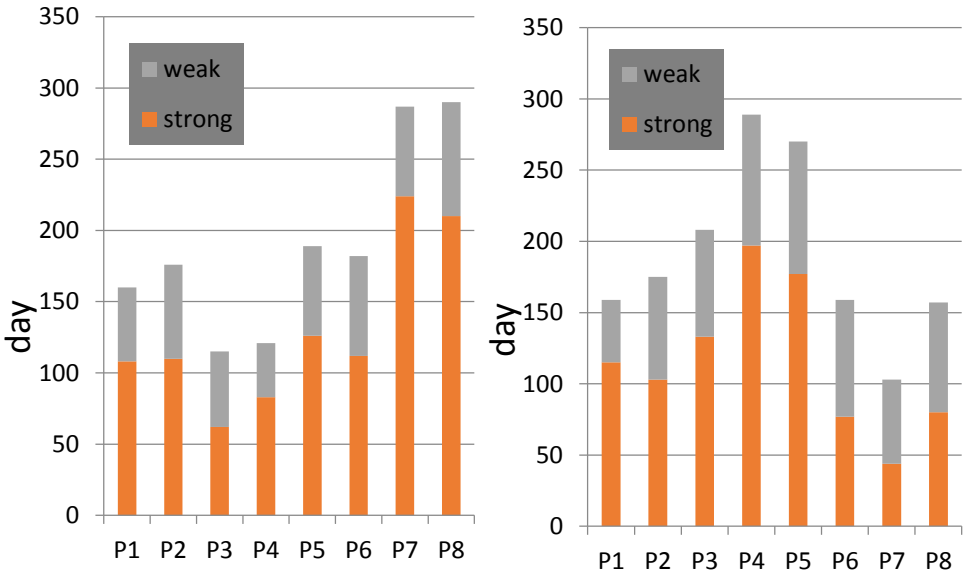
Probability forecast of TC Occurrence

Ongoing research

When BSISO1 > 1.0 & P78 in Aug. for recent 10 years : 83 days
Among them, when TCs occur : 20 days
→ 24%

When BSISO2 > 1.0 & P1 in Aug. for recent 10 years : 47 days
Among them, when TCs occur : 10 days
→ 21%

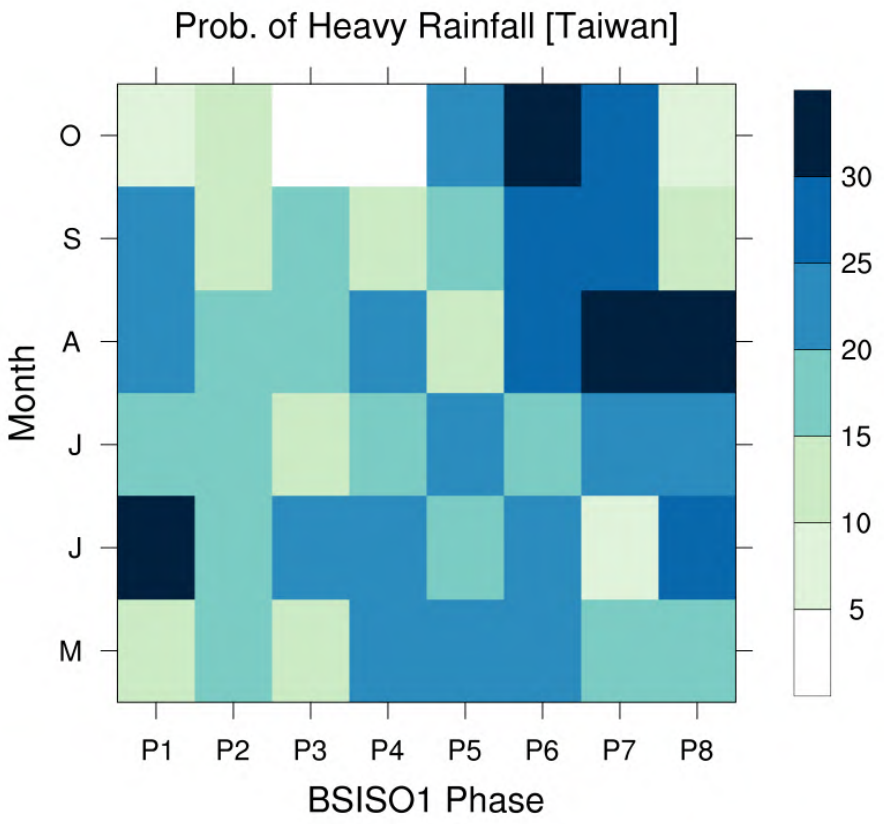
BSISO-TC relationship

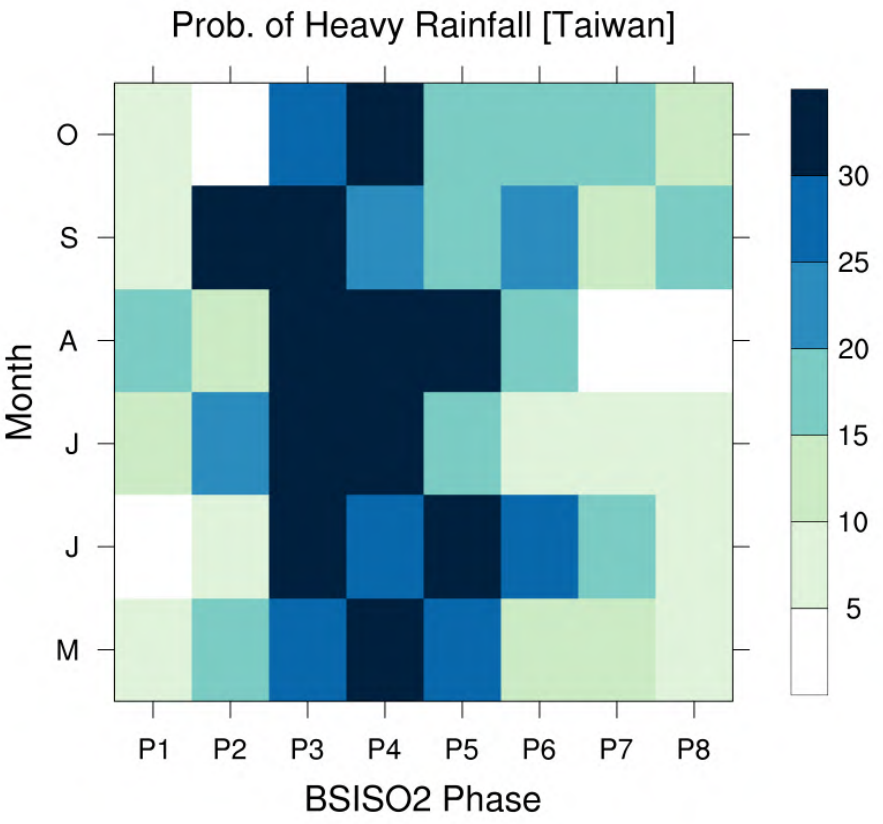


Better forecast? *practical use*

Relationship analysis ***(Composite analysis : BSISO-Heavy rainfall probability)***

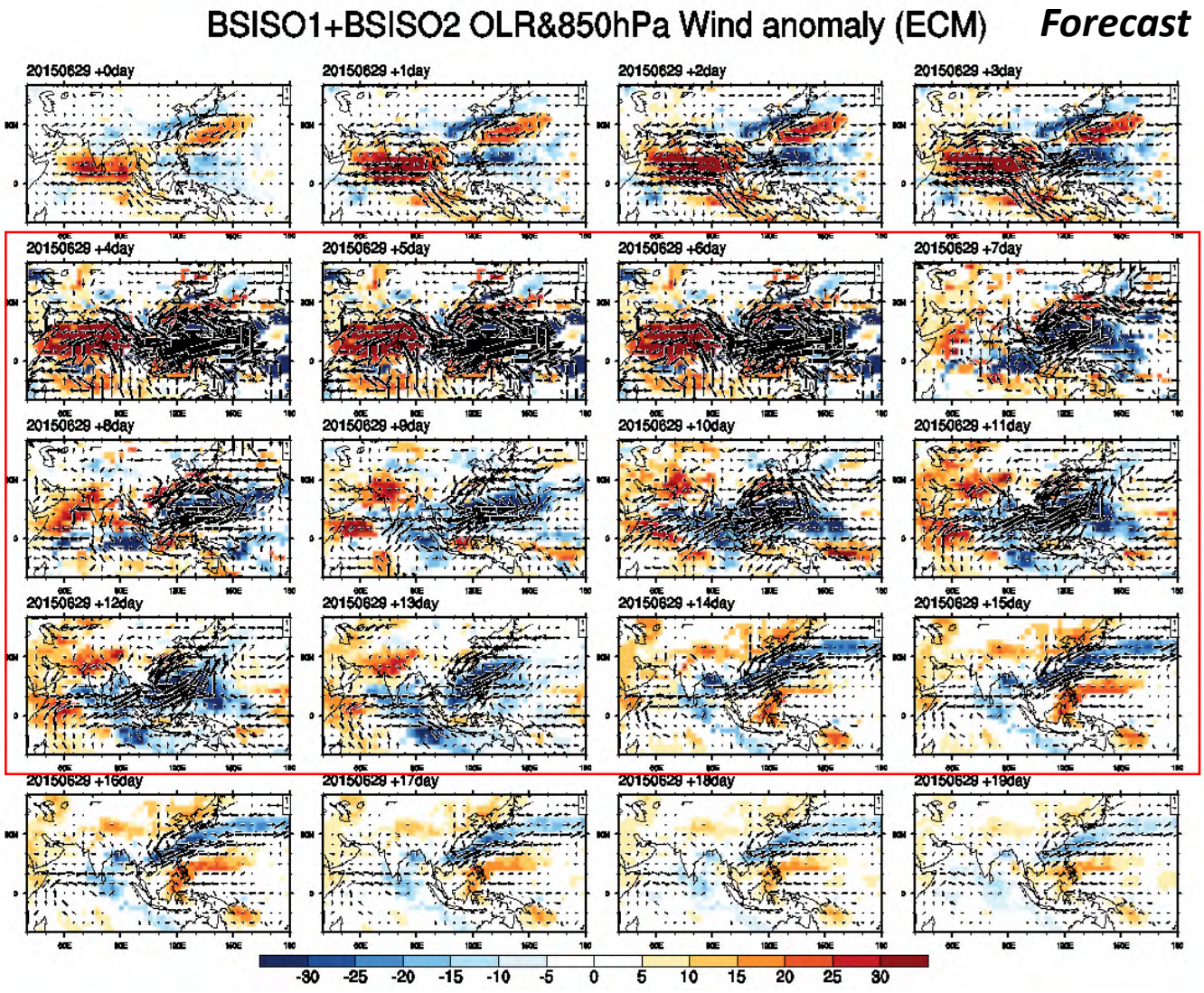
Probability of Heavy Rainfall occurrence [Taiwan]





Application Possibility : Typhoon

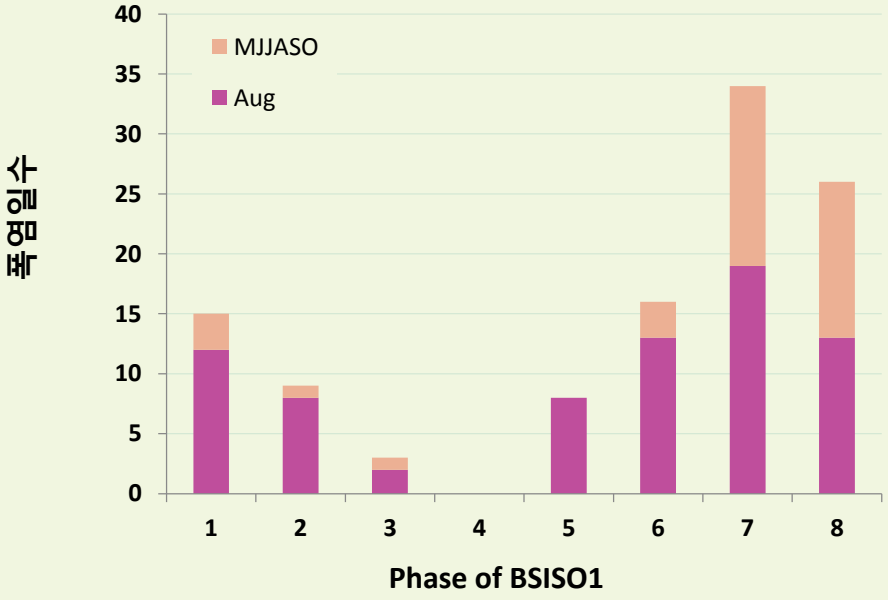
BSISO-TC activity relationship



9 : Chanhom
10 : Linfa
11 : Nangka

Application Possibility : S.Korea heatwave

BSISO-heatwave relationship



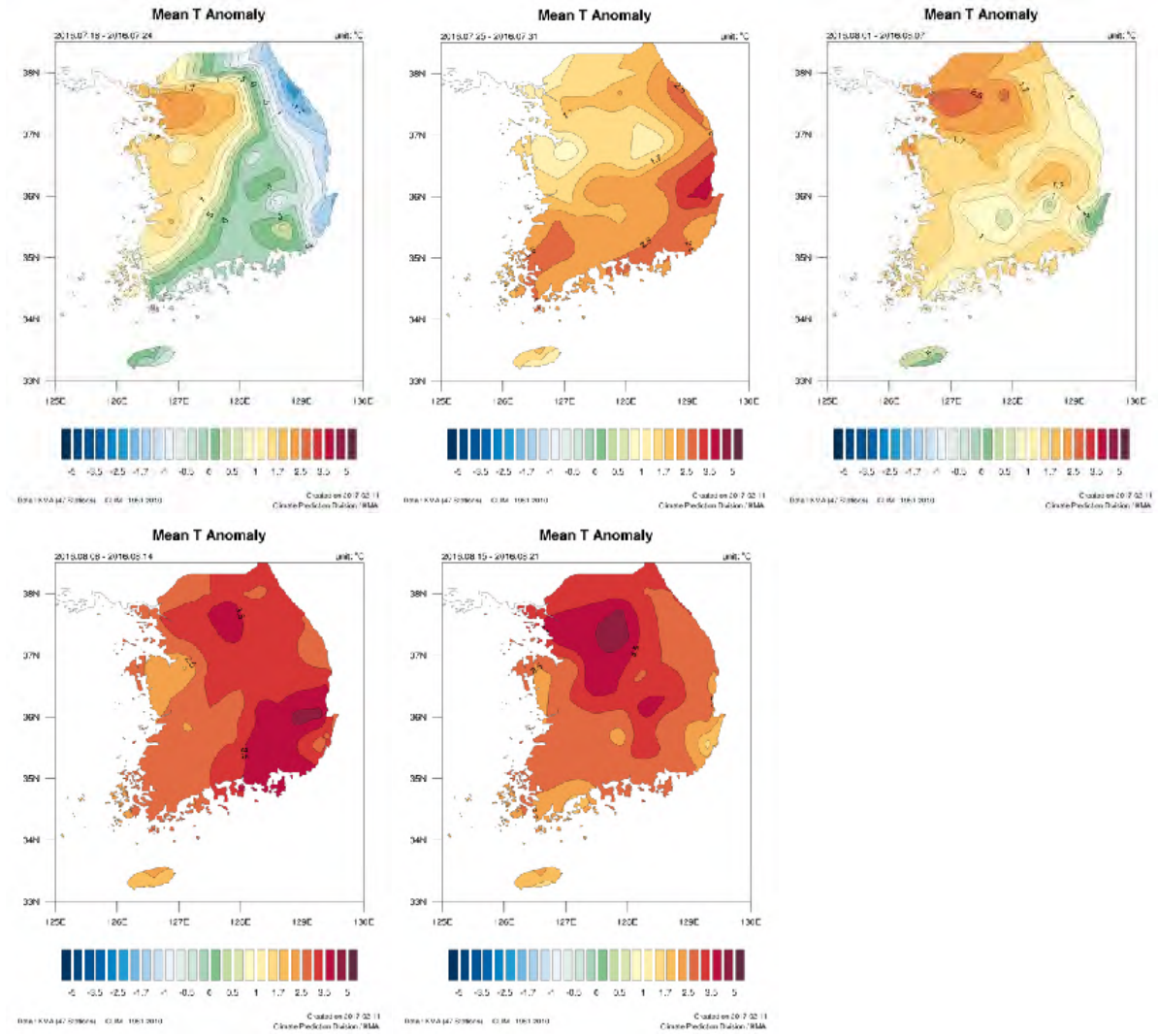
’17

폭염인 지점수가 30개 이상일 때 BSISO phase 에 따른 폭염일수
(한반도의 상당한 지역이 폭염으로 고생할 때 BSISO 와의 관련성)

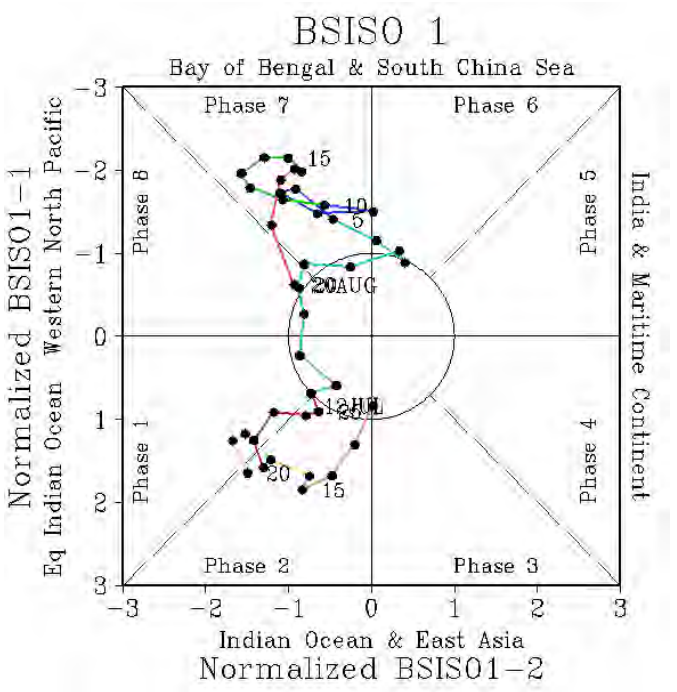
(* 폭염지수 from 이우섭 박사 (1981-2014))

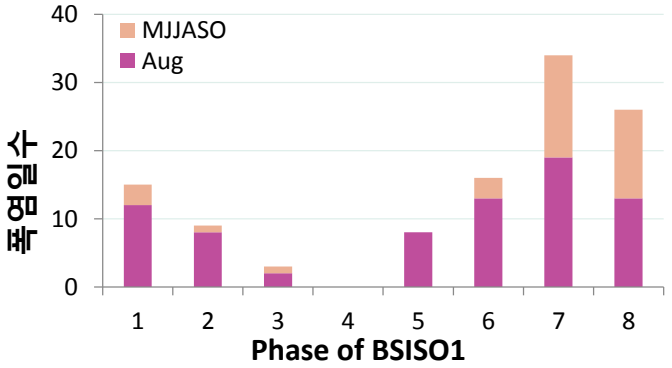
Application Possibility : S.Korea heatwave

BSISO-heatwave relationship



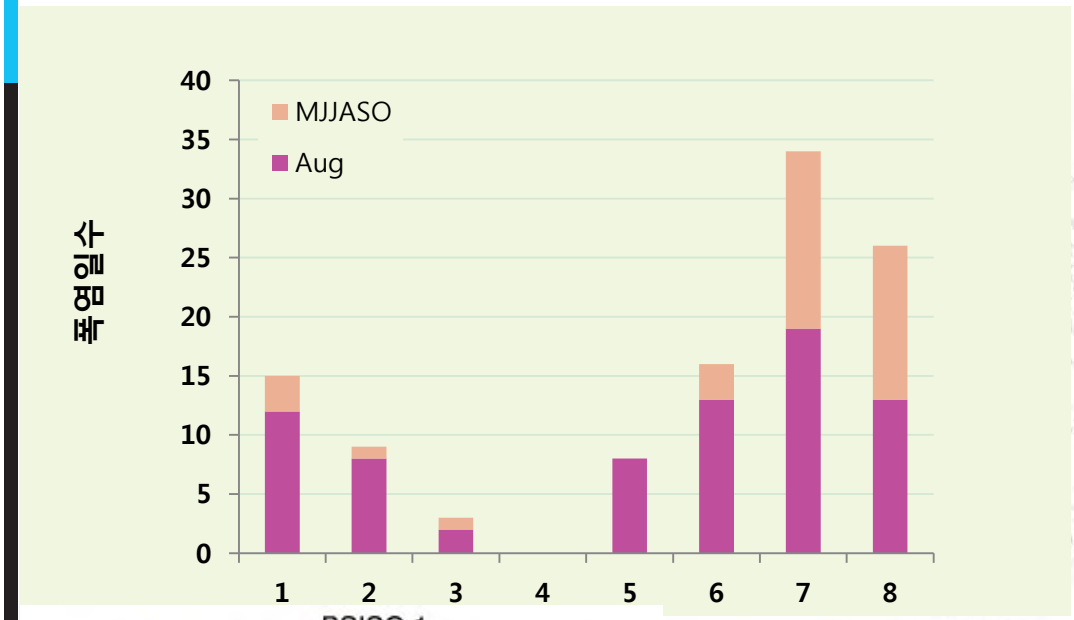
Monitoring (7/12 ~ 8/20)

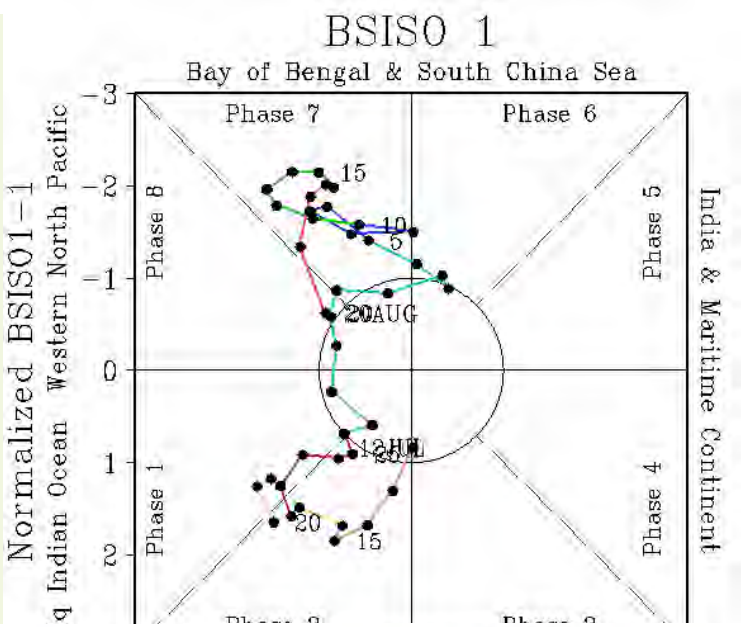




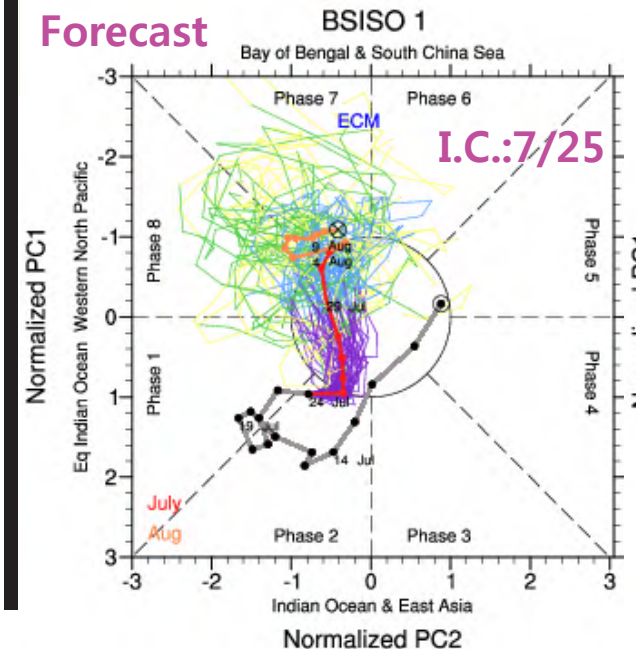
Application Possibility : S.Korea heatwave

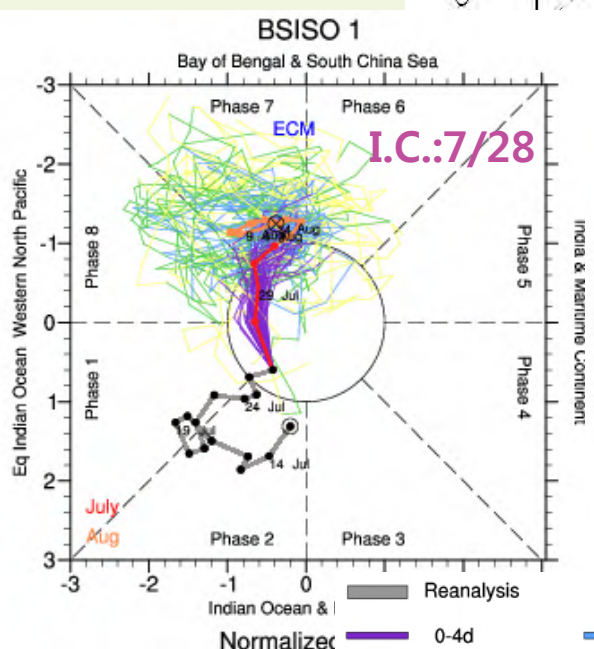
Monitoring (7/12 ~ 8/20)

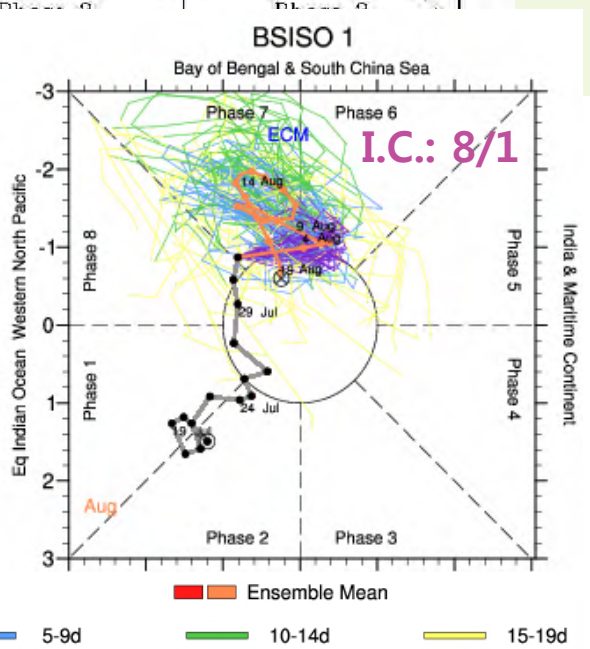




Forecast

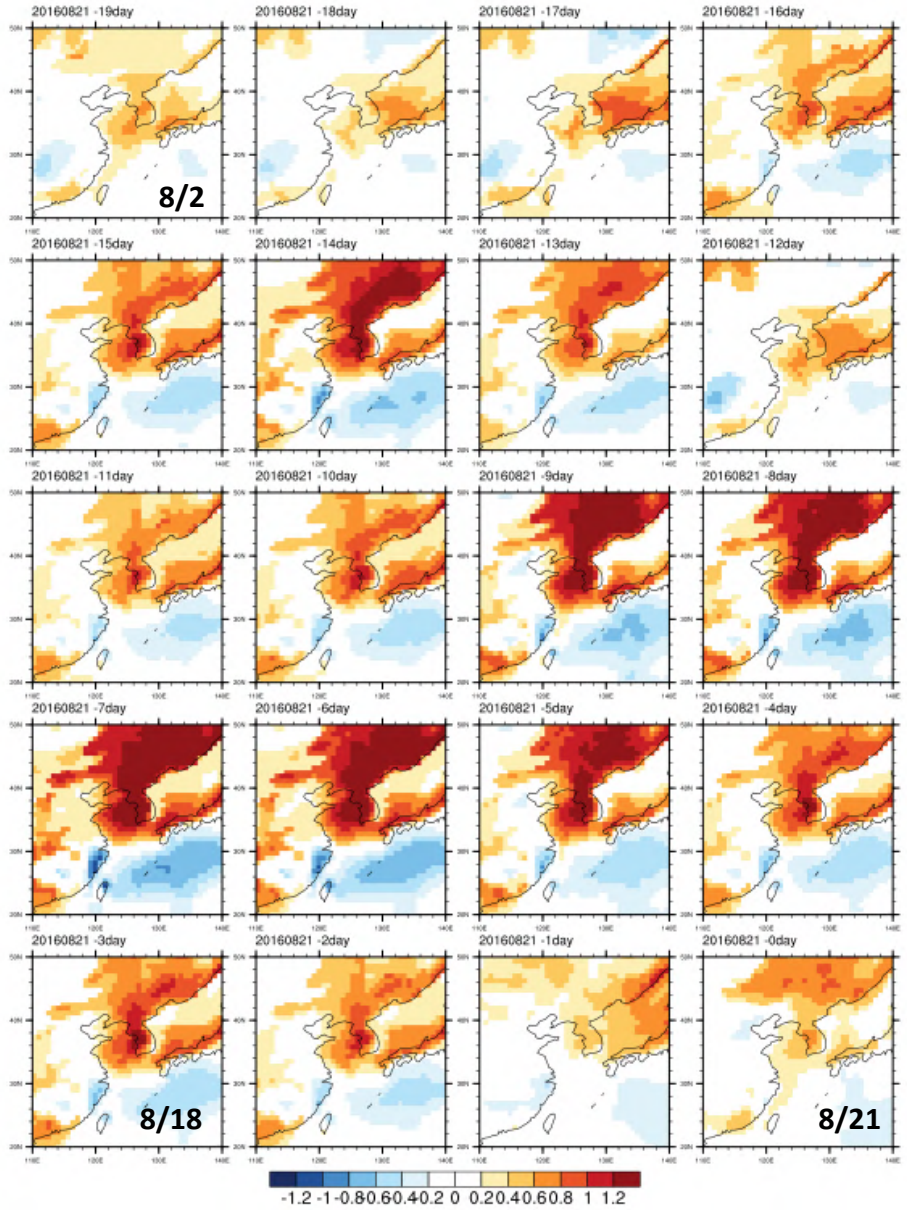




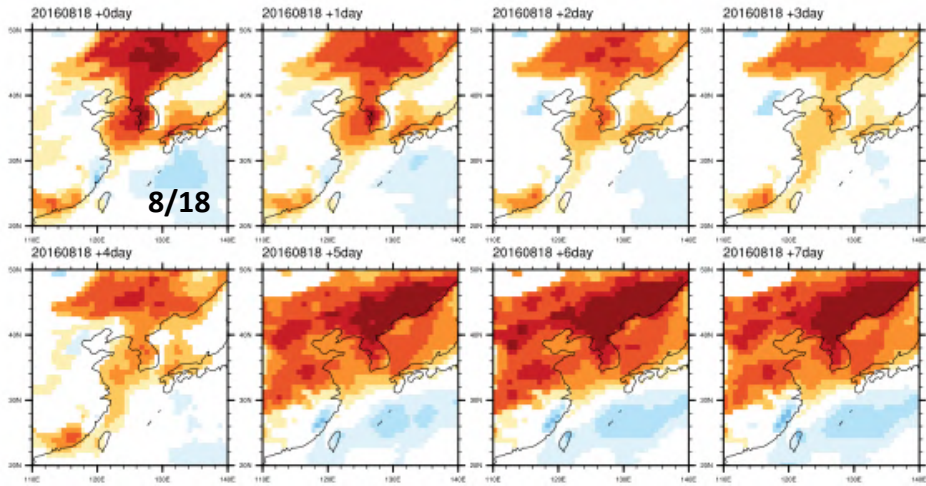


Application Possibility : S.Korea heatwave

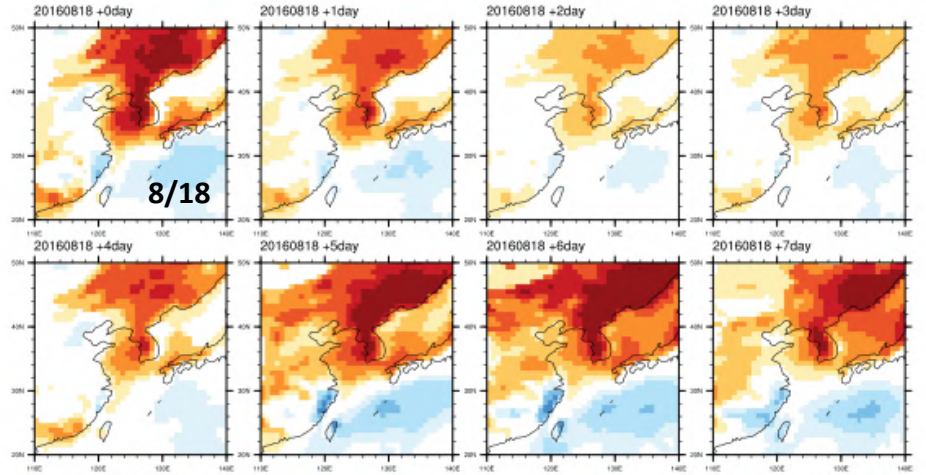
BSISO1+BSISO2 Temperature anomaly (MONITORING)



BSISO1+BSISO2 Temperature anomaly (BOM)



BSISO1+BSISO2 Temperature anomaly (ECM)



Application possibility [*S.Korea drought*]

Composite Analysis

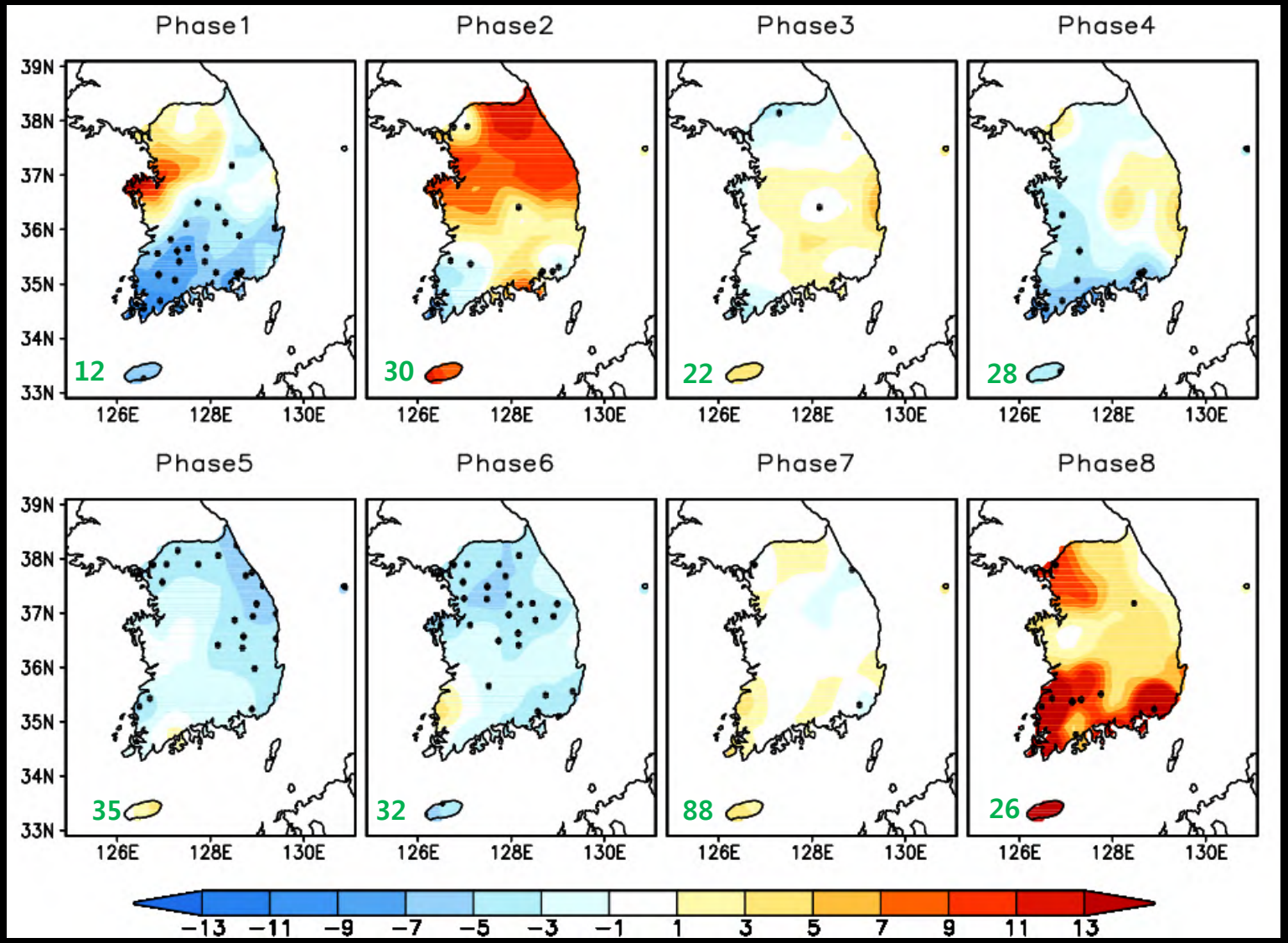
1. *89 stations over Korean Peninsula*
2. *1981~2010 (30yr)*
3. *MJJASO, MAY, JUN, JUL, AUG, JJ, JJA*
4. *Daily mean rainfall*
5. *over 1.5std of BSISO indices*

5월 (장마 전 건기)
: 겨울철 건기에 비해 강도는 약하지만 수자원 부족으로 농업을 비롯한 많은 산업에 피해를 초래

Application possibility [*S.Korea drought*]

Precipitation anomalies [BSISO1:May]

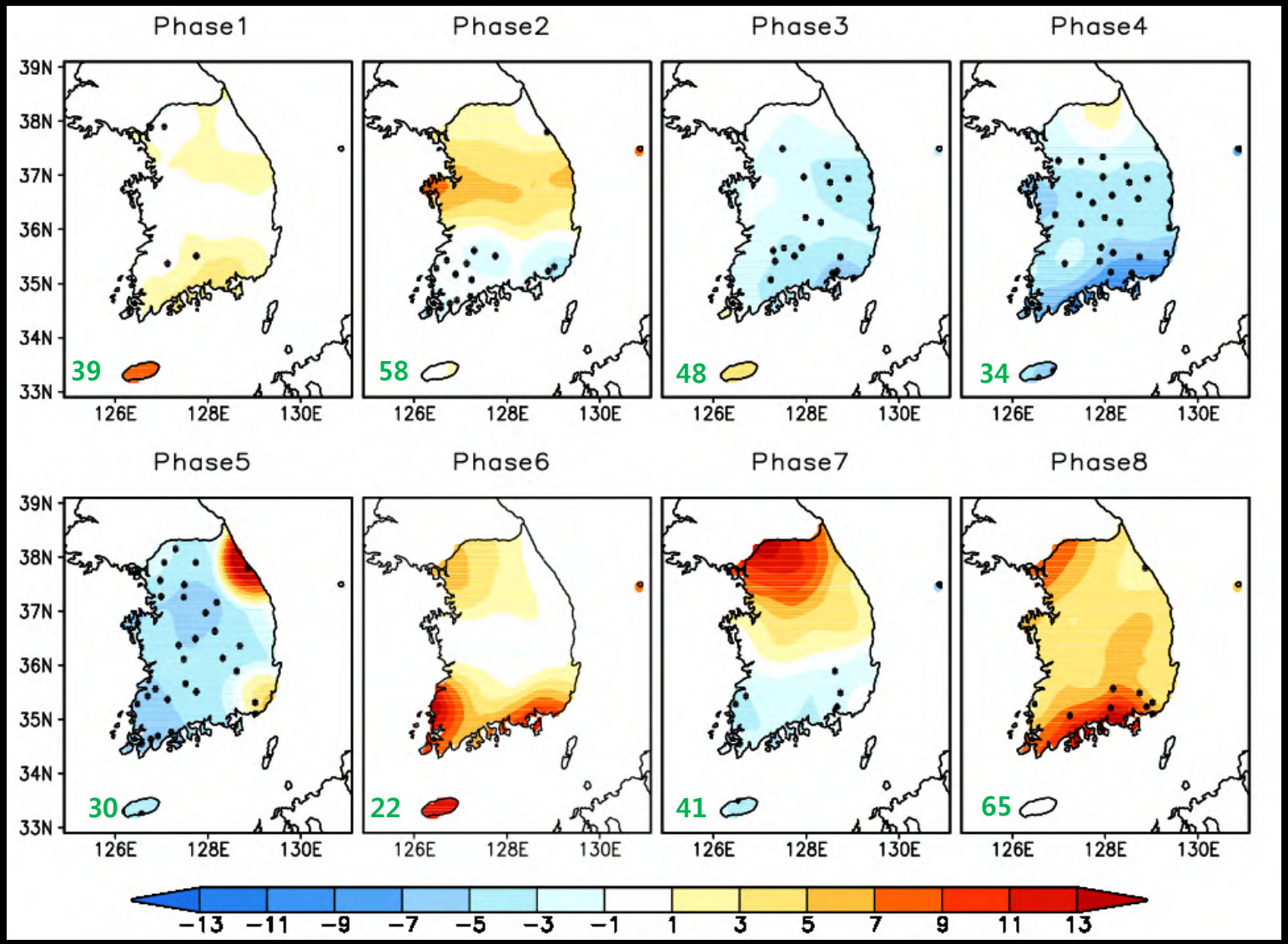
- black dot : station with significant value over 95% confidence level



Application possibility [*S.Korea drought*]

Precipitation anomalies [BSISO2:May]

- black dot : station with significant value over 95% confidence level

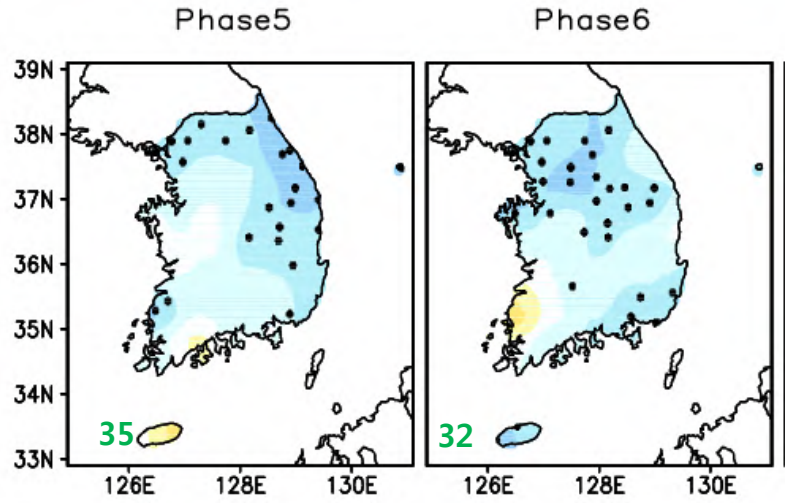


Application possibility [*S.Korea drought*]

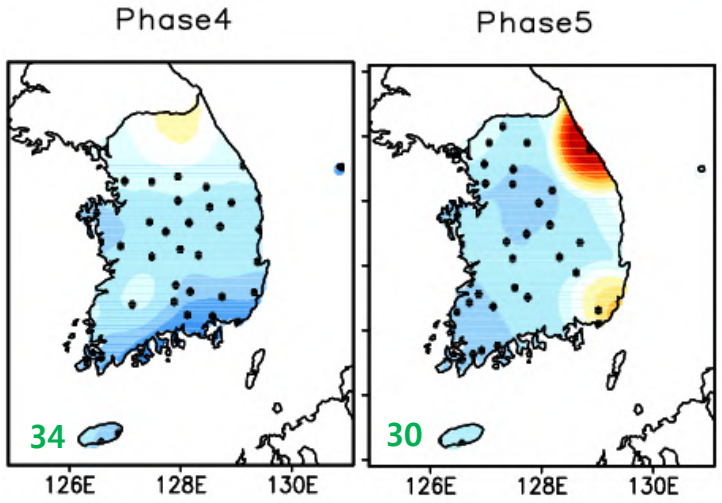
Precipitation anomalies [BSISO:May]

- black dot : station with significant value over 95% confidence level

BSISO 1



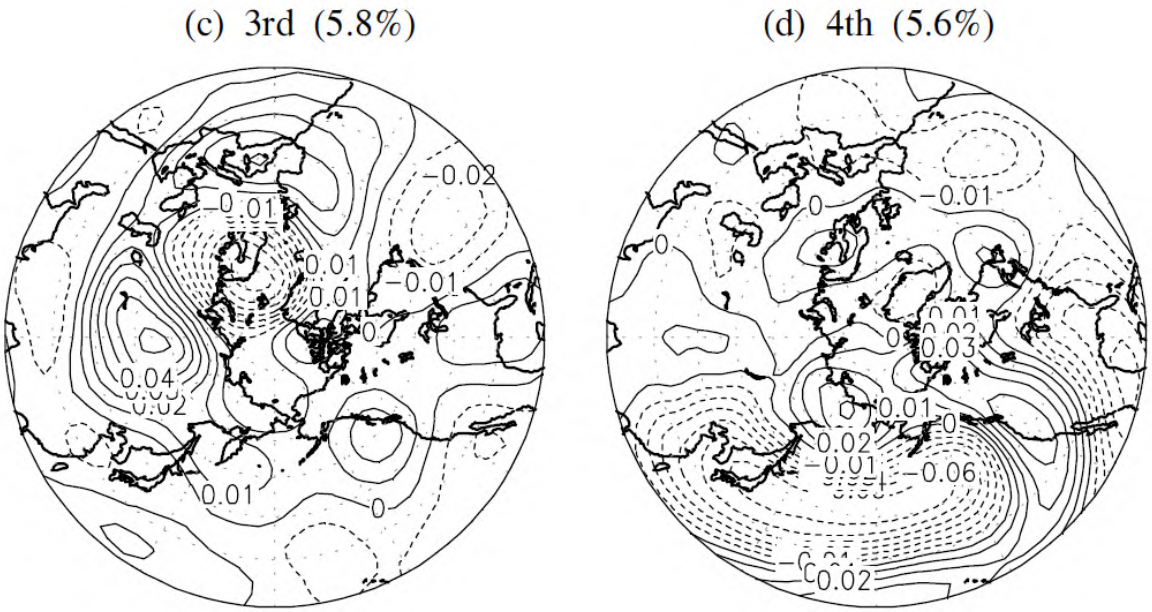
BSISO 2



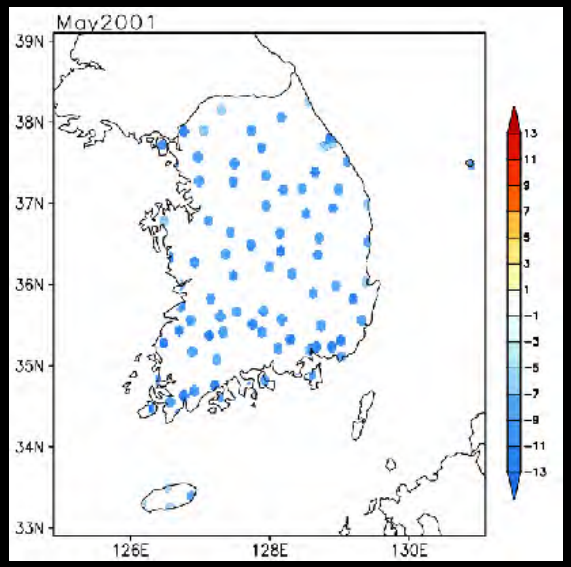
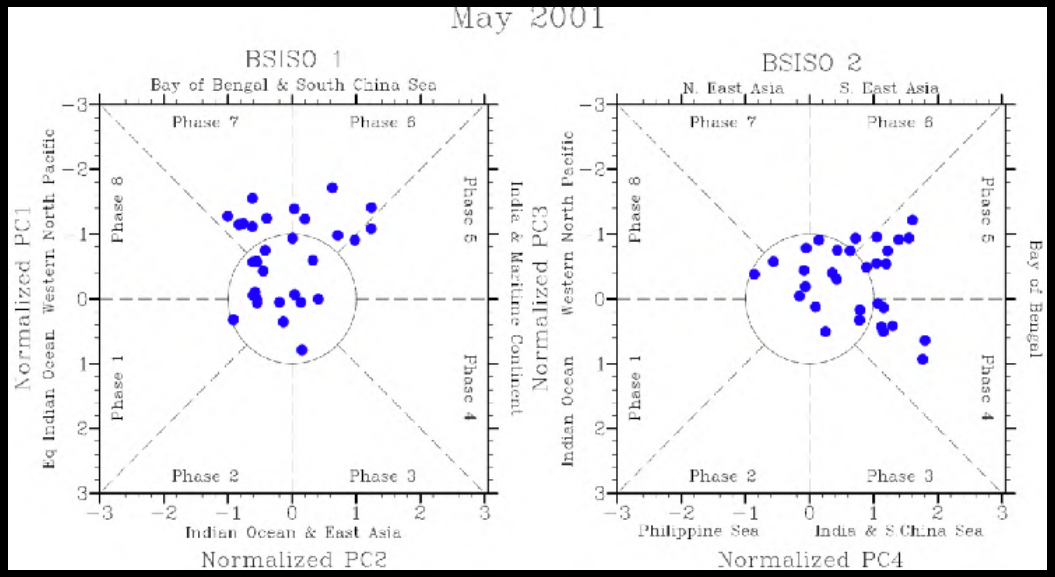
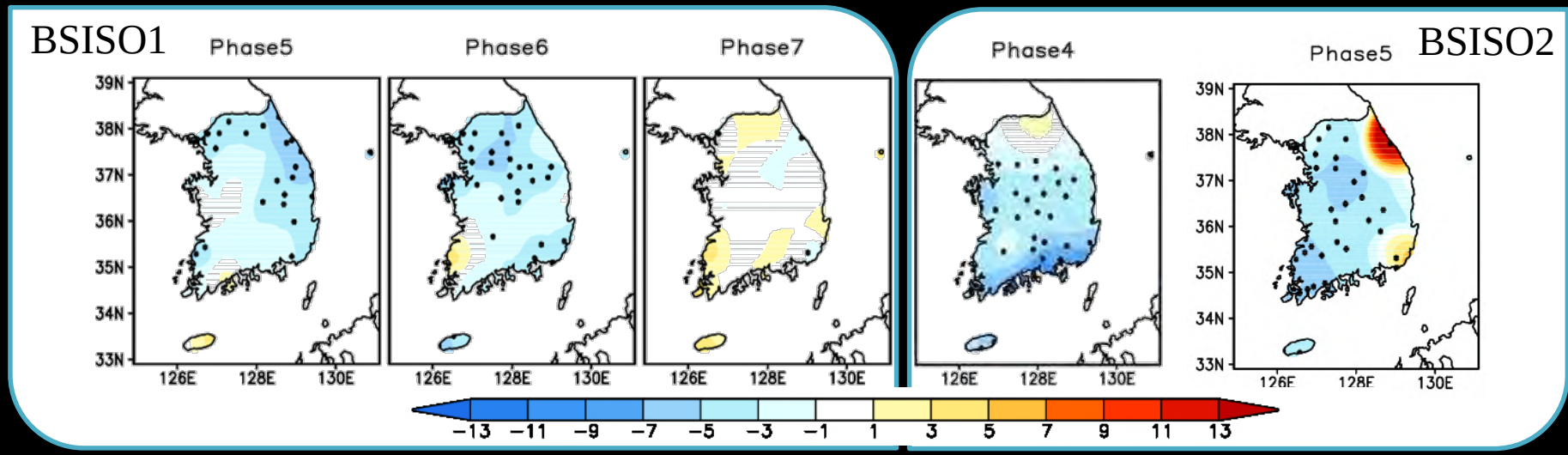
Application possibility [*S.Korea drought*]

Northern Hemispheric Circulation Responsible for the Spring Drought in Korea

1. *Scandinavia teleconnection pattern*
2. *North Pacific teleconnection pattern*



Reference [Kim et al., 2005]

Application possibility [*S.Korea drought*]

Case Study [2001:May]