문서번호 APCC-출장-16-1414(2016-12-20)

결재	선임연구원	팀장	부서장	원장
	12/14 오지현	대결 12/14 이우섭	12/15 유진호	12/20 정홍상
협조				

TRAVEL REPORT FORM
출장보고서

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측본부	본부장	유진호	'16.12.5(월)-9(금)	
기후예측본부	선임연구원	오지현	'16.12.5(월)-9(금)	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

가. 개요

- 참가 회의명: Workshop on Sub-Seasonal to Seasonal Predictability of Extreme Weather and Climate

* WWRP/WCRP S2S prediction project에서 개최하는 워크샵으로 극한현상과 기후의 S2S 예측성을 이해하고 조기경보 시스템을 개발하는데 있어 최신 연구 동향을 파악하고, 유용한 정보를 상호교환하며, 유관기관간의 교류를 활성화하고자 개최되었음.

- 일시: 2016년 12월 6일 - 2016년 12월 7일 (2일 간)
- 장소: Monell Building
  Columbia University at Lamont-Doherty Earth Observatory Campus
  61 Route 9W, Palisades, NY 10964-8000, 미국

나. 주요 업무 수행 사항

- 이틀 동안의 워크샵은 크게 세 개의 주제 (Sub-seasonal predictability, S2S extreme weather phenomena, real world prediction and use of forecast)로 구성되었음 (붙임 1)
- APCC BSISO 예측 업무 소개 및 2016년 수행된 BSISO가 동아시아 강수에 미치는 영향에 관한 연구 발표 (붙임 2)
- APCC의 S2S ICO 업무이행에 관한 절차 논의

* 참석자: 유진호, 오지현, 강현석(NIMS), 현유경(NIMS), Nakazawa Tetsuo(NIMS) Paolo Ruti (WMO), Michel Rixen(WMO)

* ICO 이행에 대한 WMO 차원의 공식화 수준에 대한 결정이 필요하며 공식화 절차를 통해 ICO를 유치한 KMA의 품위가 손상되지 않는 범위에서 공식화를 진행하기로 함.

* 기상청-APCC의 입장을 정리해 WMO의 WWRP/WCRP 담당자(Paolo Ruti, Michel Rixen)에게 수주 내에 전달해 주면 이를 바탕으로 WMO 내부 절차에 관해 논의하겠다고 함.

- 다양한 기관으로부터 백여 명이 넘는 참가자가 참석하였고 참석이 부득이한 사람은 원격으로 워크샵에 참석하는 등 S2S 프로젝트에 대한 관심이 높음을 확인할 수 있었음
- 미국은 NOAA의 MAPP라는 project를 통해 2016년 9월부터 S2S 예측성능 향상에 대한 투자가 이루어지고 있음.
- Heat(cold) wave, Tropical cyclone, blocking, atmospheric river 등과 같은 극한기상현상에 대한 예측을 가능하게 함으로써 Energy, retail, agriculture, aviation 등의 다양한 분야에 유용한 정보로 활용될 수 있음
- 보다 나은 예측 성능을 얻기 위해 앙상블 스프레드, 2주를 넘어서는 예측 정보의 성능에 있어 초기조건 vs 경계조건의 중요성 대한 논의가 이루어졌음. 이러한 측면은 향후 SCoPS 계절내 진동 예측 정보 생산에 있어 고려되어야 할 사항으로 생각됨. 아울러, High Resoultion (25km 이하) 모형의 add-value가 일부 언급되었음.
- 겨울철 Madden-Julian Oscillation(MJO)에 대한 연구는 활발하게 진행되고 있었지만 여름철 Intraseasonal Oscillation에 대한 연구는 상대적으로 적은 편으로 생각되는 바, APCC가 관련 연구의 leading position을 차지할 수 있기를 기대해 봄.
- 현재까지 S2S 프로젝트의 예측 정보가 응용 분야에 직접적으로 활용된 사례는 보고되지 않았으며 향후 APCC에서 수행될 다학제간 연구가 S2S 커뮤니티에 좋은 예시가 될 것으로 생각되어짐.

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

- 관심과 기대가 많은 project이며 미국을 중심으로 연구활동이 확대되는 움직임을 보이고 있음.
- ECMWF의 MJO예측을 제외하고는 아직까지 과학적인 예측 근거와 예측성능이 명확히 확보되지 않아 많은 연구개발을 필요로 하는 분야임.
- APCC는 BSISO를 중심으로 이 time scale의 Product를 생산하고 있는 몇 안되는 기관 중 하나이며, Subseasonal forecast를 수집, 시험생산 중인 WMO 선도센터 운영, S2S ICO 유치 등 S2S 분야의 많은 정보와 자료가 모이는 기관임.
- BSISO를 제외한 또 다른 Product의 발굴이 단시일내에 가능하지 않을 분야이나 사회적 need와 이 분야에서의 현재 APCC의 위치를 감안할 때 센터 연구개발 인력 및 재원의 일부를 더 S2S 쪽으로 투입시킬 필요가 있다고 판단됨.

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

S2S Extremes Workshop Daily Schedule

Tuesday, December 6, 2016 - All Sessions to take place in **Monell Auditorium** unless otherwise specified

AM: Sub-seasonal to Seasonal predictability Chairs: Camargo/Robertson	
9:00 AM	Welcome: A. Robertson, A. Sobel
9:20 AM	F. Vitart (ECMWF): Prediction of extreme events at Sub-seasonal to Seasonal lead times (invited)
9:50 AM	C. Jones (UCSB): Sub-seasonal forecast skill of precipitation in the contiguous United States during the 2015-16 winter (invited)
10:20 AM	E. Barnes (CSU): North Pacific blocking anticyclones, S2S dataset
10:40 AM	Coffee Break
11:10 AM	H.-M. Kim (SUNY-SB): MJO Prediction: Current Status and Future Challenges (invited)
11:40 AM	J. Perlwitz (ESRL): Role of stratospheric processes on ENSO-NAO connections on Seasonal-to-Subseasonal Timescale
12:00 PM	R. Saravanan (TAMU): Does “oceanic weather” affect atmospheric weather in the midlatitudes?
12:20 PM	Discussion
12:40 PM	Lunch will take place in **Lamont Hall**
PM: S2S extreme weather phenomena Chairs: Kim/Sobel	
1:45 PM	M. DeFlorio (NASA JPL): Prediction of Atmospheric Rivers (invited)
2:15 PM	G. Vecchi (GFDL): Towards a unified system for prediction and understanding of regional and extreme tropical cyclone activity (invited)
2:45 PM	D. Farnham (Columbia U): Seasonal climate signals, regional daily intense precipitation
3:05 PM	H. Hendon (BoM): Attribution of Extreme Heat Events Using a Seasonal Forecast Framework
3:25 PM	Coffee Break
3:50 PM	M. Tippett (Columbia U): Monthly predictions of severe weather indices in CFSv2 (invited)
4:20 PM	P. Dirmeyer (GMU): Predictability of Heat Waves Following Drought Events in the United States in S2S Models
4:40 PM	A. Lang (SUNY-Albany): The Stratosphere-troposphere Processes and their Role in Climate (SPARC) Stratospheric Network for the Assessment of Predictability (SNAP)
5:10 PM	E. Coughlan (RCCC): "Ready-Set-Go!" How S2S forecasts could help the Red Cross/Red Crescent (invited)
5:30 PM	Dscussion
6:00 PM	Poster Session and Reception will take place in **Lamont Hall**
8:00 PM	Adjourn

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Extreme Weather and Climate
COLUMBIA UNIVERSITY

Subseasonal-to-Seasonal S2S Prediction Project

NOAA

MAPP
Modeling, Analysis, Predictions, and Projection

S2S Extremes Workshop Daily Schedule

Wednesday December 6, 2016 - All Sessions to take place in **Monell Auditorium** unless otherwise specified

AM: Real world prediction and use of forecasts **Chairs: Wang/Tippett**	
9:00 AM	M. Ventrice (The Weather Co.): Weeks 3-5, sub-monthly volatility, skillful, automated sub-seasonal guidance that can be used as a platform for all forms of business (invited)
9:30 AM	A. Kumar (CPC): The utility of seasonal hindcast data base for analyzing climate variability and extremes; An example of US west coast winter precipitation variability during strong El Niño events (invited)
10:00 AM	M. L'Heureux (CPC): Capability of model forecasts to predict the 2015-16 El Nino and similarly extreme ENSO events (invited)
10:30 AM	B. Kirtman (RSMAS): The Subseasonal Experiment (SubX) (invited)
11:00 AM	Coffee Break
11:20 AM	W. Norton (City Financial): Attributing Predictable Signals at Subseasonal Timescales.
11:40 AM	P. Roundy (SUNY-Albany) : Propagation Characteristics of the MJO in Different Intraseasonal Mid to High Latitude Blocking States
12:20 PM	Discussion
12:40 PM	Lunch will take place in **Lamont Hall**
PM: Real world prediction continued, Conclusion **Chair: Vitart**	
1:40 PM	C. Lee (IRI): Relationship between Tropical Cyclones and the Madden-Julian Oscillation in the S2S dataset
2:00 PM	A. Vintzileos (CPC): Enhancing Resilience to Heat Extremes: Multi-model Forecasting of Excessive Heat Events at Subseasonal Lead Times
2:20 PM	S. Materia (CMCC) - Seasonal forecast of droughts: providing useful information to water management and agribusiness sector
2:40 PM	Concluding Discussion
3:30 PM	Coffee - Main Meeting Ends
S2S SG - MAPP TF session (4–5pm)	

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Commonality and dissimilarity between two distinct modes of Boreal Summer Intraseasonal Oscillation modulating East Asian summer precipitation and atmospheric circulation

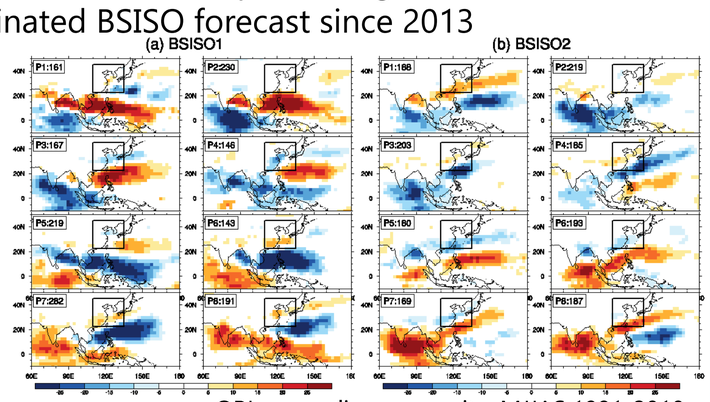
Ji-Hyun Oh[1] and June-yi Lee[2]
1.APEC Climate Center, Busan, South Korea 2. Research Center for Climate Sciences, Pusan National University, Busan, South Korea

APCC
APEC CLIMATE CENTER

Background

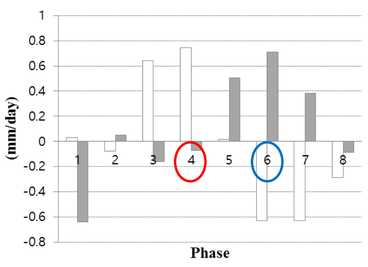
- **Boreal Summer ISO(BSISO) indices**
- Feasible for real-time ISO monitoring & forecasting
- Consists of BSISO1 & BSISO2: daily f(phase,amplitude)
- Overcome the limitation of the RMM index for representing BSISO
- APEC Climate Center has disseminated BSISO forecast since 2013

RMM index	BSISO index
Wheeler and Hendon (2004)	Lee et al (2013)
OLR, and zonal winds at 850 and 200 hPa	daily OLR and U850
Equatorial average between 15S and 15N	10S-40N, 40E-150E
All year round	MJJASO
first two leading multivariate EOF modes	The first four leading multivariate EOF modes
	BSISO1, BSISO2



ORL anomalies composite: MJJAS 1981-2010

BSISO modulating EA rainfall



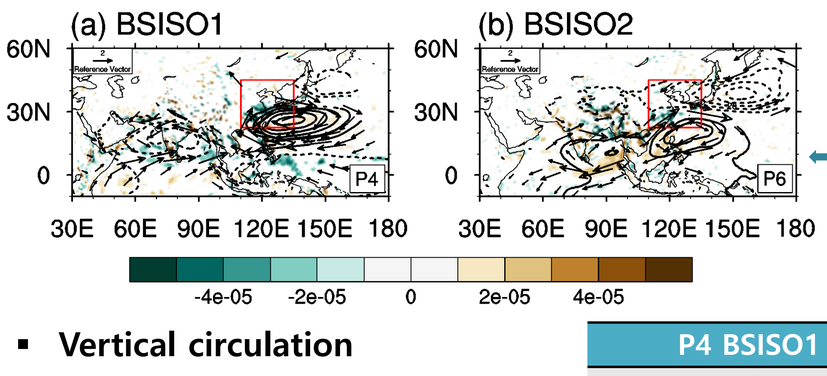
EA-averaged APHRODITE rainfall as a function of the BSISO phases

* EA: 22.5-45N, 110-135E

It is identified that phases 3–5 of BSISO1 and phases 5–7 of BSISO2 are favorable for convective activity over the EA.

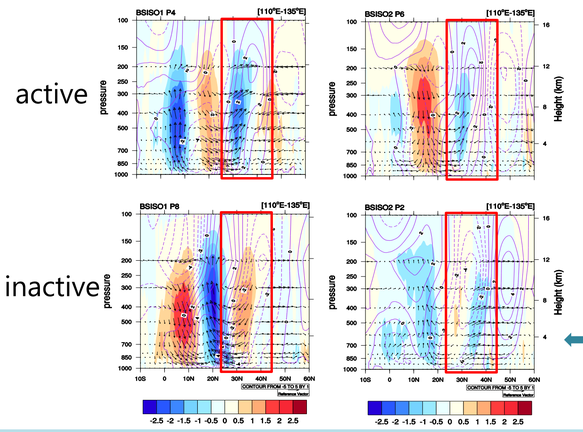
Circulation associated with BSISO1 & BSISO2

- **Horizontal circulation at 850hPa**



Composite of geopotential height (contour), moisture convergence (shaded), and wind (vector) anomalies at 850 hPa for BSISO1 phase 4(a), BSISO2 phase 6(b)

- **Vertical circulation**



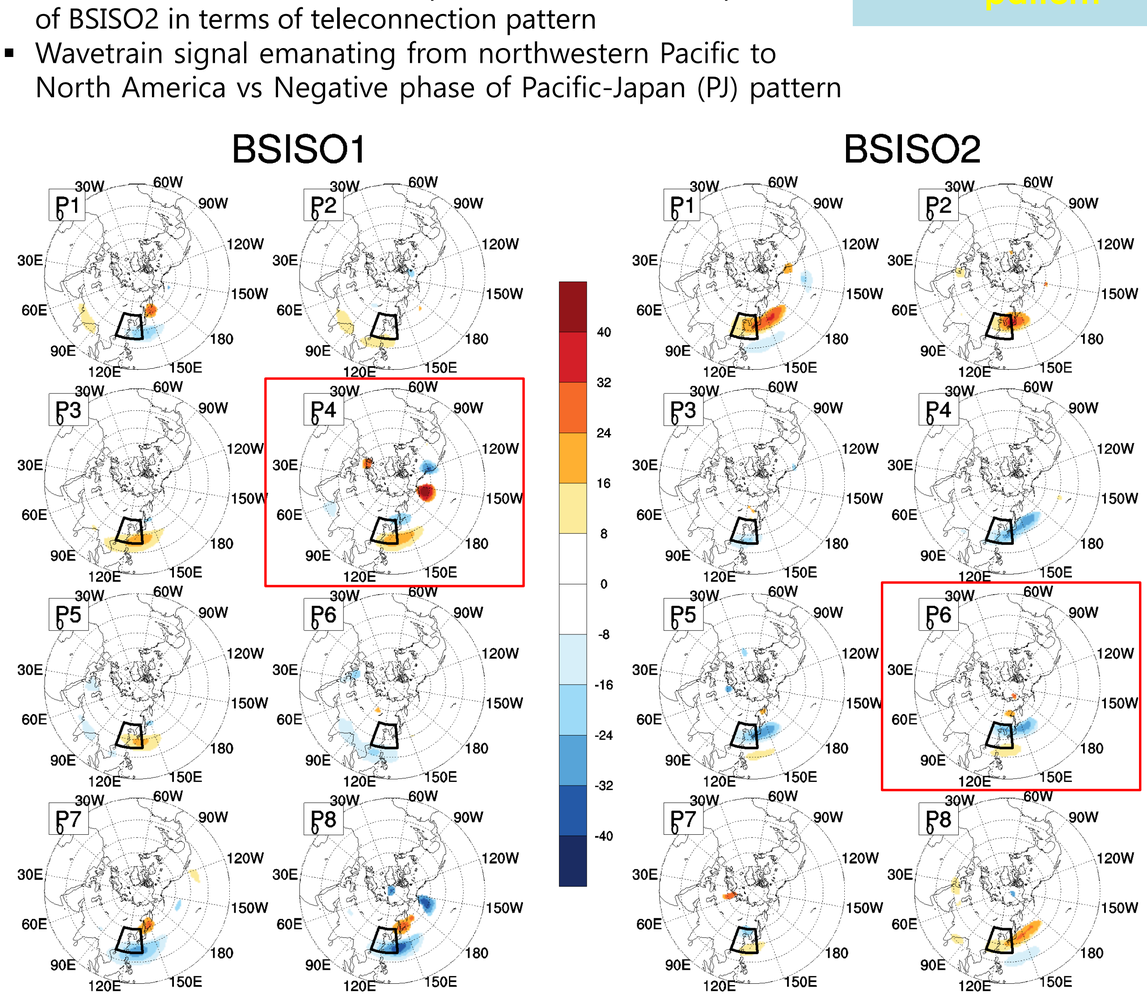
P4 BSISO1	P6 BSISO2
East-west oriented dipole	North-south oriented dipole of elongated bands

- Anomalous anticyclonic atmospheric circulation over the Philippine Sea
- Negative pressure velocity anomalies & tilting of the zonal wind in the latitudinal band of EA

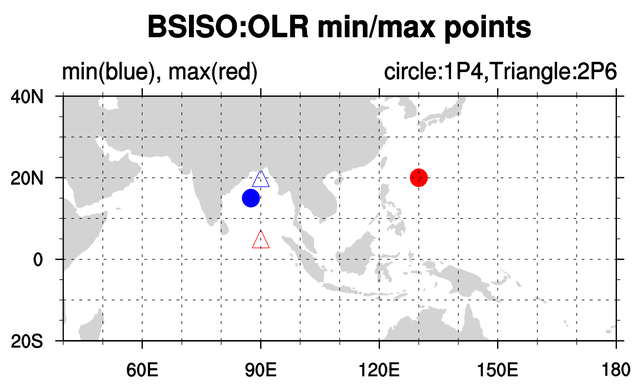
Pressure-latitude diagram of pressure velocity(shaded), zonal wind (contour) for active phases of BSISO1&2 and inactve phases of BSISO1&2

Difference in teleconnection pattern

- **BSISO1 & 2 composites of geopotential height anomalies at 500 hPa**
- Noticeable difference between phase 4 of BSISO1 and phase 6 of BSISO2 in terms of teleconnection pattern
- Wavetrain signal emanating from northwestern Pacific to North America vs Negative phase of Pacific-Japan (PJ) pattern



Heating/cooling of BSISO1 & 2

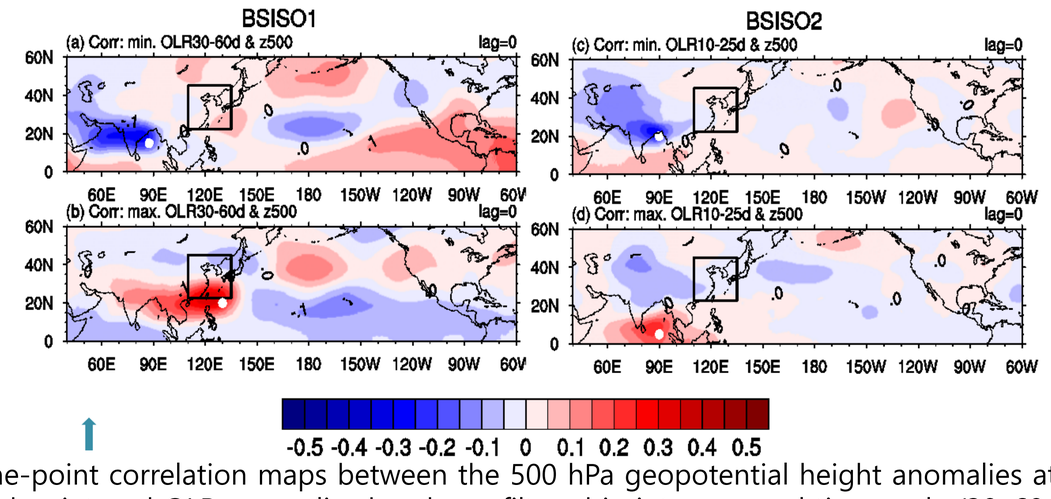


Locations where the maxima and minima identified within a domain of 20°S–40°N and 40°E–180°E on the basis of the composite of 10–60-day bandpass-filtered OLR anomalies for phase 4 of BSISO1 and phase 6 of BSISO2, respectively.

- Whereas the cyclonic and anticyclonic centers presented by circles for phase 4 of BSISO1 are situated in east-west direction, those presented by triangles for phase 6 of BSISO2 are identified in north-south direction.

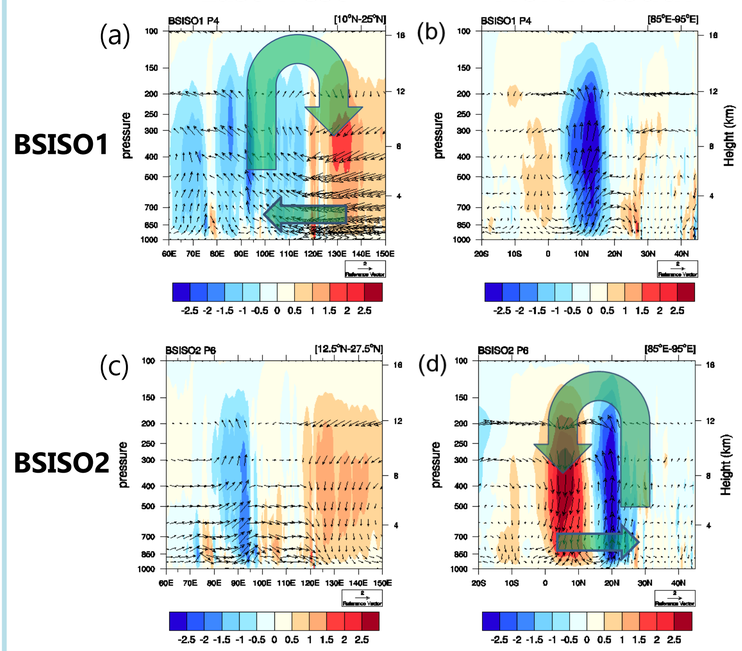
One-point correlation

- **One-point correlation maps between 500 hPa geopotential height anomalies & intraseasonally time-filtered OLR**



One-point correlation maps between the 500 hPa geopotential height anomalies at each grid point and OLR anomalies bandpass-filtered in intraseasonal time-scale (30–60-day, 10–25-day) and 2.5° circular averaged from the heating source/sink centers

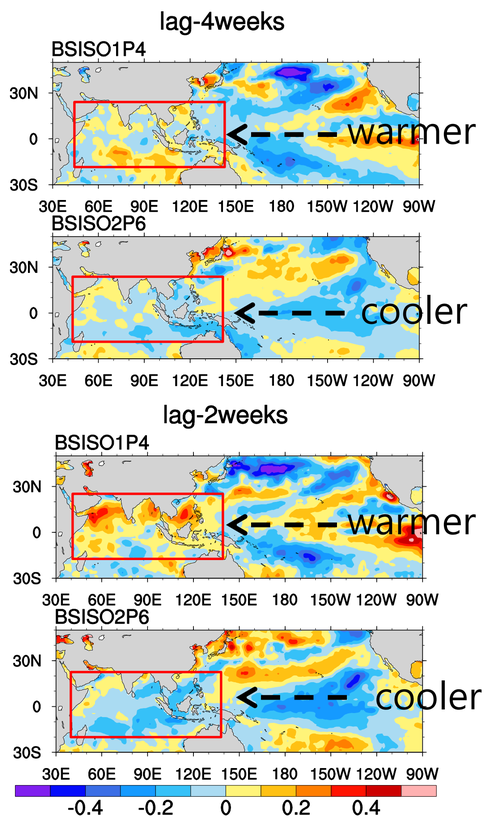
Vertical structure



- **Vertical structrure near the heating/cooling centers**
- BSISO1P4: regional Walker Circulation
- BSISO2P6: regional Hadley Circulation

SST over IO

- **SST difference between BSISO1P4 and BSISO2P6**



Changma & BSISO

Changma				BSISO1		BSISO2	
Year	Onset	Withdrwal	Duration	Amp	Phase	Amp	Phase
1981	6/19	7/14	26	1.417	*5*	2.368	3
1982	7/7	7/29	23	0.473	2	0.842	7
1983	6/19	7/25	37	1.332	**4**	0.265	2
1984	6/15	7/13	29	1.652	7	0.826	7
1985	6/21	7/18	28	2.346	*5*	1.386	2
1986	6/23	7/26	34	2.171	*5*	0.671	5
1987	7/1	8/8	39	1.22	*5*	1.312	3
1988	6/23	7/27	35	1.806	8	1.649	**6**
1989	6/23	7/29	37	1.131	7	0.291	3
1990	6/19	7/19	31	2.151	*5*	2.013	8
1991	6/26	8/2	38	0.733	3	0.41	7
1992	7/9	7/23	15	1.416	3	0.545	6
1993	6/22	7/30	39	0.701	5	0.775	7
1994	6/22	7/6	15	1.44	*5*	1.37	7
1995	6/30	7/27	28	0.648	3	0.489	3
1996	6/24	7/22	29	0.203	5	1.547	**6**
1997	6/25	7/22	28	1.233	6	0.596	2
1998	6/24	7/28	35	1.305	**4**	1.553	3
1999	6/23	7/10	18	0.305	1	3.328	**6**
2000	6/21	7/16	26	0.636	2	0.664	6
2001	6/22	7/21	30	2.169	*5*	0.676	8
2002	6/23	7/24	32	1.164	**4**	1.79	5
2003	6/23	7/25	33	1.536	3	1.712	5
2004	6/24	7/17	24	2.064	7	2.644	7
2005	6/26	7/18	23	1.286	*5*	1.083	**6**
2006	6/21	7/29	39	1.557	3	2.166	2
2007	6/21	7/24	34	2.035	**4**	1.286	2
2008	6/17	7/26	40	1.044	6	2.224	**6**
2009	6/28	7/21	24	1.642	2	1.086	7
2010	6/18	7/28	41	0.987	4	1.714	7
2011	6/10	7/10	31	1.106	*5*	2.149	**6**
2012	6/18	7/17	30	1.025	6	0.787	5
2013	6/18	8/2	46	1.648	*5*	0.728	1
2014	7/2	7/29	28	0.448	5	1.558	8
2015	6/25	7/29	35	1.1816	6	2.716	**6**
2016	6/24	7/30	32	2.304	**4**	0.806	2

- Years in yellow: co-occurrence of Changma onset & BSISO1 P4-> Post El Nino years (Xie et al. (2009)
- Years in green: co-occurrence of Changma onset & BSISO2P6