문서번호 APCC-출장-16-1092(2016-10-12)

결재	선임연구원	팀장	부서장	부서장
	10/10 함수련	10/11 김선태	10/12 유진호	대결 10/12 유진호
협조	사원	팀장		
	10/10 김보성	10/11 이우섭		

TRAVEL REPORT FORM
출장보고서

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측팀 기후연구팀	선임연구원	우성호 함수련	10/2~8 10/1~7	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- NOAA CPC에서 주관한 41th Climate Diagnostics and Prediction Workshop에 참석하여 계절예측 및 기후감시와 관련된 현황 및 최근 이슈들에 대해 토론 및 발표를 진행
- 일정/장소: 2016.10.3.~ 2016.10.6. (4일) / 미국 메인주 Orono, University of Maine
- 발표제목: Effect of El-Nino Southern Oscillation on the relationship between Arctic Oscillation and wintertime temperature over East Asia (우성호) / Seasonal prediction skill of the APCC in-house model retrospective seasonal forecasts (함수련)

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

NOAA CPC는 전 세계적으로 기후예측을 선도하는 기관 중 하나로 미국 계절 예측 현업 업무뿐만 아니라 ENSO를 포함한 전지구 기후 감시 및 예측 정보를 생산하고 제공한다. CPC는 향후 가장 중요하고 집중적으로 연구할 분야로 **3-4주 예측 및 계절예측의 향상**을 꼽고 있다고 언급했다. 특히 3-4주 예측의 경우에는 2015년 9월부터 현업서비스를 하고 있지만 **예측성의 확보가 매우 힘든 기간**이니 만큼 예측성 향상을 위한 노력이 요구된다고 강조했다. 전 세계적으로도 최근 계절내 예측에 대한 현업 예보 및 예측성 향상을 위한 노력이 진행중이며, **우리 센터도 계절내 예측에 대한 노력이 시작되고 있는만큼 지속적인 관심을 가지고 세계적인 추세에 발맞추어가는 노력이 필요**하다고 생각된다.

이번 워크샵은 최근 가장 큰 이슈였던 **2015/16 엘니뇨 및 그와 관련된 원격상관의 특성, 엘니뇨 최성기인 겨울철 계절예측의 실패에 대한 원인분석이 주요 주제**였다. 이번 엘니뇨는 과거 전형적인 엘니뇨와 유사한 적도 태평양 해수면온도의 특성을 보여주지만, 원격상관은 매우 다른 특성을 보였다는 점이 큰 특징이다. 따라서 **전형적인 엘니뇨의 대기반응을 모의하는 역학 모델의 경우에는 계절 예측이 크게 실패**하였다. 특히 북미 서남부 (캘리포니아 지역)의 강수예측은 완전히 반대로 나타나 이러한 예측 실패의 원인을 제시하고자 관측 및 모델 앙상블 멤버 자료등을 활용하여 그 이유를 분석하였다. 제시된 이유로는 Atmospheric noise, North Atlantic Oscillation과 연관된 대기패턴 예측 실패, 늦겨울 Nino3 지역의 빠른 SST 약화 모

의 실패, Global Warming등이 있다. 이러한 역학 모델의 예측 실패 원인을 분석하는 연구들은 향후 모델 개선에도 중요하게 적용된다. 향후 우리 센터도 in-house모델을 활용하여 폭염이나 한파 등의 분석을 통해 모델 개선 및 예측성 향상에 기여할 수 있을것으로 판단된다.

다른 발표 주제로는 **북극지역 기후와 중/저위도 기후의 관련성**이 있다. 북극지역은 다른지역에 비해 강한 온난화를 겪고 있으며, 그와 연관된 대기 순환 등으로 북반구 전역의 날씨와 기후에 영향을 미치고 있다. 과거에는 해빙의 감소에 의한 대기순환장의 변화가 중위도 기후에 미치는 영향에 대한 연구가 많이 진행되었는데, 이 세션에서는 대기 순환장의 변화가 해빙의 변화를 이끌수 있다는 연구 결과들이 제시되었다. **북극 해빙을 많이 녹일수 있는 순환장은 열대 변동과 연관된 자연변동성을 모델들이 실제 관측처럼 모의하지 못하기 때문에 해빙의 감소 경향을 모델이 잘 모의하지 못하며, 이러한 한계는 2015/16 겨울철 계절예측과도 연결**된다고 제시되었다. 또한 현재 대부분의 역학모델이 해빙 예측성이 떨어지는데 해빙의 변동과 관련된 중위도 기후의 영향을 고려할 때 역학모형의 해빙 예측성은 매우 중요하다고 할 수 있다. **좋은 초기 해빙 깊이와 물리역학의 개선으로 해빙 예측성이 상당히 개선될 수 있음이 제시**되었다. 또한 **성층권 초기장 개선 역시 봄철 북반구 중위도 기온의 예측성 향상을 가져올 수 있다고 언급**되었다. 이를 토대로 센터내 모형들의 성층권 순환 및 그와 연관된 대류권의 모의 성능을 분석하여 예측성 한계에 대한 원인을 조사할 필요가 있다.

본 워크샵에서 발표된 내용들과 비교해 볼 때 현재 APCC 및 기상청에서 계절 예측을 위해 감시하는 기후 요소 및 생산되는 예측자료는 세계적인 수준임을 알 수 있었다. 하지만 예측성 향상을 위한 꾸준한 노력(학계 및 연구소와의 연계를 통한 예기치 못한 기후 이벤트에 대한 즉시적 연구 지원 및 시간을 많이 요하는 분야에 대한 지속적 연구)과 새로운 정보의 효율적 제공 (계절내예측 등)을 통한 사회 기여로 기관이 지속적으로 발전할 수 있는 동력을 발굴하고자 끊임없이 노력하는 것이 매우 인상적이었다. 우리 센터의 발전을 위해서는 센터의 목적내에서 지속적인 발전을 위한 성장 동력을 발굴하기 위한 노력이 매우 중요할 것이다.

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

발표자료 첨부

1. Presented and Collected Materials 주요 수집자료

   워크샵 프로그램 첨부, 발표자료는 추후 웹사이트를 통해 제공될 예정

2. Suggestions and Remarks 건의사항

Program for the 41st Annual Climate Diagnostics and Prediction Workshop

Orono, Maine, October 3-6, 2016

Monday, October 3, 2016

07:00 – 09:00	Registration
08:45 – 09:00	**Welcoming Remarks – CPC and University of Maine**
09:00 - 09:20	**Keynote:** *Contemporary Challenges in Short-Term Climate Forecasting* **David DeWitt**, Climate Prediction Center
Session 1:	**The 2015-16 El Niño** **Chair: Mike Halpert**
09:20- 09:40	*Evolution of the 2015-16 El Niño (INVITED)* **Mike McPhaden**, NOAA/PMEL
09:40- 10:00	*The 2015-16 El Niño and What's Next* **Michelle L'Heureux** and the CPC/IRI ENSO Forecast Team, CPC/NCEP/NWS/NOAA
10:00– 10:20	*Monitoring and Diagnosis of the 2015/2016 Super El Nino Event* **Bing Zhou**, Xie Shao, Beijing Climate Centre, CMA
10:20- 10:40	*Anatomy of the 2015-2016 El Nino Episode* **Agniv Sengupta** (a), Sumant Nigam (a), Stephen Baxter (b), Alfredo Ruiz-Barradas (a), (a) Department of Atmospheric and Oceanic Science, University of Maryland, College Park, (b) NOAA/Climate Prediction Center, College Park, Maryland
10:40 – 11:10	Break
Session 2:	**The 2015-16 El Niño (continued)** **Chair: Zeng-Zhen Hu**
11:10 – 11:30	*The 2015-16 El Niño Event from Onset to Impact* **A.M. Chiodi** and D.E. Harrison, UW JISAO/NOAA PMEL
11:30 – 11:50	*Did the big El Niño of 2015-16 leave the expected footprint in the US?* **Klaus Wolter**, Andrew Hoell, and Marty Hoerling, University of Colorado-Boulder & NOAA-ESRL-PSD

11:50 – 12:10 *Evolution of Winter 2015/16 Atmospheric and Terrestrial Anomalies over North America: El Niño Response and Role of noise*
Mingyue Chen, and Arun Kumar, CPC/NCEP/NWS/NOAA

12:10 – 12:30 *Why the 2015/16 El Niño failed to bring excessive precipitation to California?*
Bor-Ting Jong, Mingfang Ting, and Richard Seager, Lamont-Doherty Earth Observatory, Columbia University

12:30 – 14:00 Lunch

Session 3: **Climate Modeling, MME, Prediction & Predictability I**
Chair: Dan Collins

14:00 – 14:20 *NMME Real-Time vs. Historical Predictability (INVITED)*
Ben Kirtman, University of Miami - RSMAS/CIMAS

14:20 – 14:40 *Do Statistical Pattern Corrections Improve Seasonal Climate Predictions in NMME Models?*
Tony Barnston and Michael Tippett, Int'l Research Inst for Climate & Society (IRI), Columbia Univ

14:40 – 15:00 *Long-Range Prediction using the North American Multi-Model Ensemble (NMME) and Climatological Observations for Maritime Prediction and Analysis Support Service (COMPASS)*
Alison O'Connor(a), Zac Bathen (a), Ben Kirtman(b), Ray Bell(b), and Joe Gorman(a), Charles River Analytics(a), University of Miami(b)

15:00 – 15:20 *Nonstationarity in the magnitude and seasonality of extreme precipitation over U.S. Climate Regions*
Shaleen Jain (1) and Nirajan Dhakal (2), (1) Department of Civil and Environmental Engineering, University of Maine; (2) Environmental and Health Sciences Program, Spelman College

15:20 – 15:50 Break

Session 4: **Climate Prediction & Predictability I (continued)**
Chair: Jon Gottschalck

15:50 – 16:10 *Predictability of Week 3-4 Average Temperature and Precipitation over the Contiguous United States*
Timothy DelSole and **Laurie Trenary**, George Mason University

16:10 – 16:30 *A New Method for Determining the Optimal Lagged Ensemble*
Laurie Trenary, Center for Ocean-Land-Atmosphere Studies and George Mason University

16:30 – 16:50 *Sub-seasonal Precipitation and Temperature Skill and Predictability using the Extended Range NCEP Global Ensemble Forecasting System*
Christopher Melhauser, Wei Li, and Yuejian Zhu, NOAA NCEP EMC/IMSG

16:50 – 17:10 *Estimation and correction of the GFS systematic errors*
Kriti Bhargava, Eugenia Kalnay, Jim Carton and Fanglin Yang, University of Maryland

17:30 – 20:00 **Ice Breaker**

Tuesday, October 4, 2016

07:30 - 09:00 Registration

Session 5: **ENSO**
Chair: Michelle L'Heureux

08:30 – 08:50 *The NOAA El Niño Rapid Response Field Campaign*
Robert Webb (and many others), NOAA OAR Physical Sciences Division

08:50 - 09:10 *A re-examination of the relationship between ENSO and the "short rains" of East Africa*
Sharon E. Nicholson, Florida State University

09:10- 09:30 *Remarkable increase in global sea surface temperature in 2014 and 2015: how was it related to El Niño and decadal variability?*
Yusuke Urabe, Tamaki Yasuda, Hitomi Saitou, Kazuto Takemura Yoshinori Oikawa and Shuhei Maeda, Climate Prediction Division, Japan Meteorological Agency / Meteorological Research Institute

09:30–09:50 *Atmospheric Secular Mode and Its Possible Impact to Recent El Nino Teleconnection*
Peitao Peng and Arun Kumar, CPC/NCEP/NWS/NOAA

09:50- 10:10 *North American wintertime temperature anomalies: the role of El Nino diversity and differential teleconnections*
Mussie T. Beyene & Shaleen Jain, University of Maine

10:10 – 10:40 Break

Session 6: **ENSO (continued)**
Chair: Arun Kumar

10:40 – 11:00 *Interaction between the Indian Ocean Dipole and ENSO Associated with Ocean Subsurface Variability*
Hui Wang, Arun Kumar, and Raghu Murtugudde, CPC/NCEP/NWS/NOAA and the University of MD

11:00 – 11:20 *Distinct patterns of Tropical Pacific SST Anomaly and Their Impacts on North American Climate*
Yuanyuan Guo and **Mingfang Ting**, Lamont-Doherty Earth Observatory, Columbia University

11:20 – 11:40 *Does Vertical Temperature Gradient of the Atmosphere Matter for El Niño Development?*
Zeng-Zhen Hu, Bohua Huang, Yu-heng Tseng, Wanqiu Wang, Arun Kumar, Jieshun Zhu, and Bhaskar Jha, CPC/NCEP/NWS/NOAA

11:40 – 12:00 *What is the variability in US west coast winter precipitation during strong El Niño events?*
Arun Kumar, CPC/NCEP/NWS/NOAA

12:00 – 13:40 Lunch

Session 7: **Climate Modeling, MME, Prediction & Predictability II**
Chair: Ben Kirtman

13:40 – 14:00 *Multi-Model Seasonal Forecasting at Environment and Climate Change Canada (INVITED)*
Bill Merryfield and **Marko Markovic**, Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada

14:00 – 14:20 *Subseasonal-to-Seasonal Science and Prediction Initiatives of the NOAA MAPP Program*
Heather Archambault, Dan Barrie, and Annarita Mariotti, NOAA Climate Program Office

14:20 – 14:40 *Improved climate prediction services for Australia*
Robyn Duell, David Jones, Oscar Alves, Andrew Watkins, Australian Bureau of Meteorology

14:40 – 15:00 *Status of Week 3-4 activities at the Climate Prediction Center*
Jon Gottschalck, NOAA / Climate Prediction Center

15:00 – 15:30 Break

Session 8: **Climate Modeling, Prediction & Predictability II (continued)**
Chair: Kirk Maasch

15:30 – 15:50 *Assessment of Ensemble Regression to Combine and Weight Seasonal Forecasts from Multiple Models of the NMME*
Dan Collins, NOAA/NCEP Climate Prediction Center

15:50 – 16:10 *Calibration and Combination of CHFP precipitation forecasts over South America using Ensemble Regression*
Marisol Osman and Carolina Vera, Centro de Investigaciones del Mar y la Atmosfera (CIMA-CONICET/UBA)

16:10 – 16:30 *Validation and calibration of multi-scale catchment rainfall forecasts for use by reservoir managers in East Africa*
Emily E Riddle, NCAR

16:30 – 16:50 *Moist thermodynamical changes (heat stress) in the 21st Century using Weather Research and Forecast model*
Jonathan R Buzan, Purdue University

17:00 – 20:00 **Poster Session**

Wednesday October 5, 2016

08:00 – 09:00 Registration

Session 9: **Prediction, Attribution & Analysis of High Impact Extreme Climate Events**
Chair: Bradfield Lyon

08:30 – 08:50 *Enhancing Resilience to Heat Extremes: Forecasting Excessive Heat Events at Subseasonal Lead Times (Week-2 to Week-4)*
Augustin Vintzileos, University of Maryland - ESSIC/CISC-MD

08:50 – 09:10 *Assessing Temperature Record Trends in Maine and New Hampshire*
Chris Kimble, NOAA/NWS Gray, Maine

09:10 – 09:30 *A New Dataset to Analyze Extreme Events in New England*,
Muge Komurcu, Massachusetts Institute of Technology

09:30 – 09:50 *February 2015: A Month to Remember in New England for Record Cold*
Corey Bogel, NOAA/NWS/Caribou Forecast Office

09:50 – 10:10 *Prediction and Predictability of Atmospheric Rivers*
Duane Waliser, JPL/Caltech

10:10 – 10:40 Break

Session 10: **Extreme Climate Events (continued)**
Chair: Muthuvel Chelliah

10:40 – 11:00 *Relative Impacts of Mitigation, Temperature, and Precipitation on 21st-Century Megadrought Risk in the American Southwest (INVITED)*
Toby Ault, Cornell University

11:00 – 11:20 *Causes of Extreme Ridges that Induce California Droughts*
Haiyan Teng, NCAR and Grant Branstator

11:20 – 11:40 *Monitoring and Prediction System for Flash Droughts over the United States*
Kingtse C. Mo, Climate Prediction Center and Dennis P. Lettenmaier

11:40 – 12:00 *Storm Tracks and their Influence on High Impact Weather in the Southern Hemisphere Winter*
Katherine E. Lukens and E. Hugo Berbery, University of Maryland, CICS-MD

12:00 – 12:20 *A Global Perspective on the Seasonal Prediction of Drought and Pluvials by the NMME During 2015-16*
Bradfield Lyon, University of Maine

12:20 – 13:50 Lunch

Session 11: **Extreme Climate Events (continued)**
Chair: Shaleen Jain

13:50 – 14:10 *Understanding the Role of Land-Atmospheric Interaction in the NCEP Coupled Forecast System (CFS) on Drought Forecast for the 2011 and 2012 US Droughts*
Rongqian Yang and Mike Ek, EMC/NCEP/NWS and IMSG

14:10 – 14:30 *Attribution and Prediction of China Droughts across Scales*
Xing Yuan, RCE-TEA, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

14:30 – 14:50 *Three-Dimensional Structure of Synoptic Waves over West Africa based on Empirical Orthogonal Functions*
Yuan-Ming Cheng, Chris D. Thorncroft and George N. Kiladis, University at Albany, State University of New York, Albany, NY

14:50 – 15:10 *Is the Active Atlantic Hurricane Era over?*
Muthuvel Chelliah, CPC/NCEP/NWS

15:10 – 15:40 Break

Session 12: **Climate Services**
Chair: Marina Timofeyeva

15:40 – 16:00 *Consultation with industry to improve Australia's climate prediction services*
Robyn Duell, Alison Cook, Jeff Sabburg, Helen Bloustein, Andrew Watkins, David Jones, Australian Bureau of Meteorology

16:00 – 16:20 *The Influence of Teleconnection Patterns on MCS Initiation Locations within the United States Corn Belt*
Elisabeth Callen, Iowa State University

16:20 – 16:40 *Application of seasonal rainfall forecasts to inform the implementation of drought contingency triggers in selected water supply reservoirs in Texas,*
John Zhu, Texas Water Development Board

16:40 – 17:00 *Delivering NOAA's Climate Information at Regional Scales, Examples on ENSO and Drought*
Ellen Mecray, NOAA Regional Climate Services Director, Eastern Region

17:30 – 20:30 **Banquet**

Thursday October 6, 2016

08:00 – 09:00 Registration

Session 13: **Arctic Climate & Linkages to Lower Latitudes**
Chair: Sean Birkel

08:30 – 08:50 *Influence of the recent high-latitude atmospheric circulation change on summertime Arctic sea ice (INVITED)*
Qinghua Ding, Axel Schweiger, Michelle L'Heureux, David Battisti, Nathaniel Johnson, Eduardo Blanchard Wrigglesworth, Qin Zhang, Kirstin Harnos, Ryan Eastman, Eric Steig, University of California, Santa Barbara

08:50 – 09:10 *Arctic Change Influence on Mid-latitude Weather (INVITED)*
Judah Cohen, AER/MIT

09:10 – 09:30 *Inhibition of Arctic summer sea-ice melting and East Asian spring rainfall increase by western-central Pacific heating*
Song Yang, Sun Yat-sen University, China
Chudi Hu, Zhenning Li, Qigang Wu, Bian He, Junwen Chen, Kaiqiang Deng, Tuantuan Zhang and Chengyang Zhang

09:30 – 09:50 *Verification of experimental sea ice forecasts at the NCEP Climate Prediction Center*
Thomas Collow, INNOVIM, LLC, Wanqiu Wang and Arun Kumar, NOAA CPC

09:50 – 10:10 *Climate Scale Outlooks of Spring River Ice Break-up in Alaska*
Richard l. Thoman Jr, NOAA/NWS/Alaska Region

10:10 – 10:40 Break

Session 14: **Arctic Climate & Linkages to Lower Latitudes (continued)**
Chair: Richard Thoman

10:40 – 11:00 *Recommendations on Categorizing Arctic Air Mass Intensity/Coverage and Improving the Monitoring of Arctic Source Regions Across The Northern Hemisphere*
Victor Nouhan, National Weather Service Forecast Office, Caribou, Maine

11:00 – 11:20 *Seasonal Prediction Skill of Northern Extratropical Surface Temperature Driven by the Stratosphere*
Liwei Jia, Xiaosong Yang, Gabriel Vecchi, Richard Gudgel, Thomas Delworth, Stephan Fueglistaler, Pu Lin, Adam A. Scaife , Seth Underwood and Shian-Jiann Lin, Princeton University/GFDL

11:20 – 11:40 *Advancing NOAA NWS Arctic Program Development*
Marina Timofeyeva, Fiona Horsfall, Jenna Meyers, Michael Churma, and Richard Thoman, NOAA NWS

11:40 – 12:00 *Climate Drivers of Tundra Vegetation Greening/Browning in the Arctic*
Uma Bhatt, University of Alaska Fairbanks

12:00 – 13:30 Lunch

Session 15:	**General Session: Climate Diagnostics, Prediction & Analyses** **Chair: Stephen Baxter**
13:30 – 13:50	*Cluster analysis of tropical modes* **Carl Schreck**, Cooperative Institute for Climate and Satellites - North Carolina (CICS-NC)
13:50 – 14:10	*Systematic errors in surface marine air temperature observations and their impact on the MERRA2 atmospheric reanalysis increments* James A Carton and **Kriti Bhargava**, University of Maryland
14:10 – 14:30	*Prototype new NOAA reanalyses for climate applications - 20CR version 3 and a replacement for NCEP/NCAR reanalysis version 1 (R1x)* **Jeff Whitaker**, NOAA Earth System Research Lab
14:30 – 14:50	*Rediscovering the MJO Extratropical Response: Streamfunction as a Preferred Variable for Subseasonal Teleconnection Analysis* **Stephen Baxter**, NOAA/NWS/NCEP/CPC
14:50	Workshop Adjourn

Program for the 41st Annual Climate Diagnostics and Prediction Workshop

Orono, Maine, October 3-6, 2016

Tuesday, October 4, 2016

17:00 – 20:00 **Poster Session**

ENSO & Recent Climate Anomalies

P.1 *A staged communication approach to advising Australian industry on the risk of El Niño or La Niña developing*, Robyn Duell, Felicity Gamble, Andrew Watkins, David Jones, Australian Bureau of Meteorology

P.2 *A New Framework to Monitor and Understand ENSO in Real-Time Applications*, Michael J. Ventrice, The Weather Company, an IBM Business

P.3 *Understanding the ENSO - Great Plains Low-Level Jet Relationship in the CMIP5 Models,* James F. Danco and Elinor R. Martin, University of Oklahoma

P.4 *Impact of ENSO in different phases of PDO on Moroccan Climate in Winter and Spring,* Atika Kasmi and Samir Saadane, Direction de la Meteorologie Nationale/Morocco

P.5 *Sea Surface Salinity and Surface Chlorophyll Variations During the 2015/ 2016 El Nino,* Li Ren; Pingping Xie; Shaorong Wu; Arun Kumar, NOAA/NCEP/Climate Prediction Center; INNOVIM, LLC

P.6 *Structure of the 2015-16 El Nino Event in MERRA-2 Including a Comparison with Previous Strong Events*, Young-Kwon Lim, NASA Goddard Space Flight Center, Global Modeling and Assimilation Office

Prediction, Attribution, and Analysis of High Impact Extreme Climate Events

P.7 *Future Heat Stress Projections and their Effects on New England Livestock,* Emma McCabe, Earth Systems Research Center, Univ. of New Hampshire

P.8 *Anomalous Rainfall in East Asia during summer and Its Association with the Aspect of East Asian Westerly Jet*, QingYun Zhang, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing

P.9 *Statistical Prediction of Seasonal Tornado and Hail Activity in the United States,* Hui Wang, Kirstin Harnos, and Arun Kumar, NOAA Climate Prediction Center

P.10 *Variability and change in daily precipitation extremes stemming from north Atlantic tropical cyclones in the eastern United States,* (1)Nirajan Dhakal and (2) Shaleen Jain, (1) Environmental and Health Sciences Program, Spelman College, (2) Department of Civil and Environmental Engineering, University of Maine

P.11 *Enhanced NCEP GLDAS for Real Time Global Drought Monitor,* Jesse Meng, EMC/IMSG

P.12 *The Roles of Radiative Forcing, Sea Surface Temperatures, and Atmospheric and Land Initial Conditions in U.S. Summer Warming Episodes*, Liwei Jia, GFDL/Princeton University and Gabriel A. Vecchi, Xiaosong Yang, Richard G. Gudgel, Thomas L. Delworth,William F. Stern, Karen Paffendorf, Seth D. Underwood and Fanrong Zeng

P.13 *An operational drought monitoring system for the Caribbean and Central America,* Miliaritiana Robjhon and Wassila Thiaw, NOAA Climate Prediction Center

P.14 *Enhanced NCEP GLDAS for Real Time Global Drought Monitor*, Jesse Meng, EMC/IMSG

P.15 *Forecasting The Early March Middle and Lower Mississippi Valley Flooding Event Via The Recurring Rossby Wave*, Joseph Renken, KOPN Radio 89.5FM

P.16 *The Quantification of Rainfall Needed to Overcome Drought: Study in North Texas*, Jasmine Montgomery, Southern Climate Impacts Planning Program (SCIPP) and Nelun Fernando, Texas Water Development Board (TWDB)

Arctic Climate Variability & Change

P.17 *Gridded Climate Products for Applications to Wildland Fire Management in Alaska,* Uma S Bhatt, University of Alaska Fairbanks

P.18 *Prediction of seasonal Arctic sea ice extent using the NMME,* Kirstin Harnos, Michelle L'Heureux, and Qin Zhang, NOAA Climate Prediction Center and Innovim LLC

P.19 *Effect of the El-Nino Southern Oscillation on the Relationship between Arctic Oscillation and Wintertime Temperature over East Asia,* Sung-Ho Woo, Hyun-Kyung Kim, So-Young Yim, Jeongwon Park, Seongeun Lee, APEC Climate Center, KMA

P.20 *The Rapid Arctic Warming of January 2016: Impacts, Processes, and Predictability*, Simon Wang, Henry Y-H Lin, M.-Y. Lee, and Kathy Pegion, Utah State University

Model & multi-model ensemble predictions & predictability

P.21 *Exploring the impact of the SST on the extended range forecast using the NCEP Global Ensemble Forecast System,* Wei Li, Yuejian Zhu, Malaquias Peña, Xiaqiong Zhou, Dingchen Hou, Christopher Melhauser

P.22 *An Analysis of Sesaonal Predictability of SST, Precipitation and Geopotential Height at 200 hPa in NMME Hindcasts,* Bhaskar Jha and Arun Kumar, Innovim LLC and NOAA Climate Prediction Center

P.23 *Seasonal prediction skill of the APCC in-house model retrospective seasonal forecasts,* Suryun Ham, APEC Climate Center

P.24 *Evaluating Fourier predictions of tropical rainfall using both observations and model data,* Carl Schreck, Cooperative Institute for Climate and Satellites - North Carolina (CICS-NC)

P.25 *Evaluation of an NMME-based Hybrid Prediction System for Eastern Pacific Hurricane Season Activity,* Christina Finan, Hui Wang, and Jae-Kyung Schemm, Innovim LLC and NOAA CPC

P.26 *Moisture Mode Processes and MJO Predictability in Coupled NAVGEM/HYCOM Hindcasts,* Matthew Adam Janiga, James Ridout, Maria Flatau, Neil Barton, Carolyn Reynolds, University Corporation for Atmospheric Research

P.27 *Integration of Systems Engineering into Weather-Climate Model Optimization*, Jiayu Zhou and David DeWitt, OSTI/NWS/NOAA and NOAA CPC

P.28 *Large-scale controls on Atlantic tropical cyclone activity on seasonal time scales,* Young-Kwon Lim, NASA Goddard Space Flight Center, Global Modeling and Assimilation Office

P.29 *Assessing the potential of a long-term climate forecast for Cuba using the WRF model,* Lourdes Ãlvarez-Escudero, Institute of Meteorology, Cuba

P.30 *Characterization of climate model errors over North America at climate and NWP timescales using the NARCCAP RCM, CMIP5-AMIP and Transpose-AMIP experiments*, Ambarish V Karmalkar, Northeast Climate Science Center, Univ of Massachusetts Amherst

P.31 *Skill and predictability in multimodel ensemble forecasts for Northern hemisphere regions with dominant winter precipitation*, Muhammad Azhar Ehsan, Center of Excellence for Climate Change Research (CECCR), King Abdulaziz University, Jeddah Saudi Arabia

P.32 *GEFS v11 Reforecast and its Applications*, Dingchen Hou, Hong Guan and Yuejian Zhu, EMC/NCEP/NWS/NOAA

P.33 O*bjective, temporally and spatially skill-weighted consolidation of dynamical model forecasts for Week-2 outlooks*, Scott Handel, CPC/NCEP

P.34 *Preliminary Results of Evaluation of Week 3-4 Reforecast Data from Environment Canada*, Qin Zhang, Dan Collins and Jon Gottschalck, Climate Prediction Center NCEP/NWS/NOAA

P.35 *Assessing Performance of Calibrated Multi-Model Ensembles in the 3-4 Week Forecast Period*, Kyle MacRitchie, Dan Collins and Jon Gottschalck, Innovim and Climate Prediction Center

P.36 *Roles of Remote and Local Forcings in the Variation and Prediction of Regional Maritime Continent Rainfall in Wet and Dry Seasons*, Tuantuan Zhang, Song Yang, Xingwen Jiang, and Bohua Huang, Sun Yat-sen University;Institute of Plateau Meteorology, China Meteorological Administration; Center for Ocean-Land-Atmosphere Studies

P.37 *The contribution of high resolution medium range forecast to the improvement of hydro-climate prediction,* Li Xu & Kingtse Mo, CPC/NCEP

P.38 *Observed tropical climate variability influences on North American temperature and precipitation forecasts for weeks 3 and 4,* Daniel Harnos, Nathaniel Johnson, Stephen Baxter, Michelle L'Heureux, and Adam Allgood, NOAA/NCEP/NWS/CPC (Harnos, Baxter, L'Heureux, Allgood); NOAA/GFDL/Princeton University (Johnson)

P.39 *Evaluating CPC's Long-Lead Climate Outlooks,* Stephen Baxter, NOAA/NWS/NCEP/CPC

Climate Events & Risk Management / Climate Services

P.40 *Early spring ice-out in Maine lakes: Identifying wintertime weather-climate thresholds and ENSO-related climate risk,* Mussie T. Beyene & Shaleen Jain, University of Maine

Climate Attribution, Analysis & Reanalysis

P.41 *Variations of Mid-Atlantic Trough and Associated Climate Anomalies,* Mengmeng Lu, Kaiqiang Deng, Song Yang, Guojun Zhou, and Yaheng Tan, School of Atmospheric Sciences, Sun Yat-sen University, Guangzhou, China

P.42 *A Preliminary Examination of a Conventional ENKF Atmospheric Reanalysis,* Wesley Ebisuzaki (1), Arun Kumar (1), Jeffrey Whitaker (2), Jack Woollen (3), Hyun-Chul Lee (1), Leigh Zhang (1), (1) CPC/NCEP, (2) PDS/OAR (3) EMC/NCEP

P.43 *Initial Assessment of the Conventional Observation Reanalysis,* Li Zhang, Arun Kumar, Jeffrey Whitaker, Jack Woollen, Wesley Ebisuzaki, Hyun-Chul Lee, INNOVIM, CPC/NCEP/NWS/NOAA, PSD/OAR/NOAA

P.44 *Precipitation Diurnal Cycle Depicted in the CMORPH Satellite Observations and Four New Global Reanalyses,* Pingping Xie and Shaorong Wu, NOAA Climate Prediction Center

41th Climate Diagnostics and Prediction Workshop

Seasonal prediction skill of the APCC in-house model retrospective seasonal forecasts

Suryun Ham, A-Young Lim

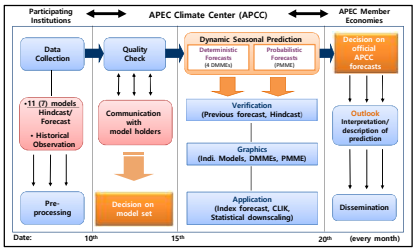
APEC Climate Center, Busan, Korea

(suryun01@gmail.com)

Background

- **APCC had produced 3-month-leading seasonal prediction data by multi-model-ensemble (MME) skill since 2005.**
- **At present, 16 agencies from the world are participating for monthly-rolling 3-month seasonal prediction. APCC-MME has various model set.**
- **Monthly-rolling 6-month-leading seasonal prediction has established since Sep.2013; 7 agencies are participating.**

Time Schedule of MME Forecast



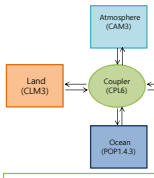
Seamless Coupled Prediction System

- The APCC has developed the in-house global climate prediction system with a research group of the University of Hawaii to improve the seasonal forecast skills.
- SCoPS consists of high-resolution atmosphere-ocean-land-sea ice coupled model with improved initialization schemes for predicting subseasonal to seasonal climate.
- For operational providing seasonal climate prediction, the capabilities of this system should be analyzed for various target seasons, different regions and time periods with a wide range of variables

➔ **Evaluation of forecast skills from the SCoPS hindcast (compare to the CCSM3 hindcast)**

APCC in-house models

- Community Climate System Model version 3 (CCSM3)
  - APCC MME participant model



	Atmosphere	Ocean
Horizontal	T85 (1.4°x1.4°)	gx1v3(0.3°-1°)
Vertical	L26	L40

- NCAR in USA
- Coupling frequency : 1/day
- 78 CPUs in APCC HPC (ATM:32, LSM:12, OCN:24, CSIM:8, Coupler:2)
- Integration time : approx. 5hr/7month

Reference : Collins WD, Bitz CM, Blackmon ML, Bonan GB, Bretherton CS, Carton JA, Chang P, Doney SC, Hack JJ, Henderson TB et al (2006) The community climate system model version 3 (CCSM3). J Clim 19(11):2122–2143

Initialization method: Ocean Temp. 3D nudging

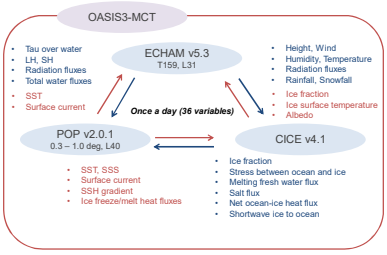
CCSM3
- CCSM3 POP1.4.3
- Ocean Temp. nudging
- Global/40 levels
- 5 days relaxation time
- Jan 1, 1982 ~ recent

Pentad 3D Ocean Temp. → Daily 3D Ocean Temp. (Linear interpolation)

- Initial condition of CCSM3 Hindcast simulation
- Restart files of ATM, LSM, OCN, ICE

- Hindcast Simulation with ICs from Ocean Temp. Nudging
  - Ensemble members : 10
  - Ensemble generation methods: Time lagged forecasting method [Brankovic et al. 1990]
    - ATM/LSM/ICE ICs: the 1st, 6th, 11th, 16th, 21st , and the last 5 days of every month
    - Ocean IC: 22 ~ 26th every month
  - Hindcast period: 1982~2014 (33 years)
  - 7month integration

- Seamless Coupled Prediction System (SCoPS)
  - Newly developed model



Initialization method: Integrated Atm.-Ocn. initialization

SCoPS
- Integrated Atmosphere-Ocean Initialization : combining 3-D atmospheric initialization and the advanced Ensemble Adjustment Kalman Filter (EAKF) methods
- Jan 1, 1982 ~ recent
- 50S – 50N, till 400meter

CFSR atmosphere variable, XBT & ARGO ocean variable (Forecast: ARGO only)

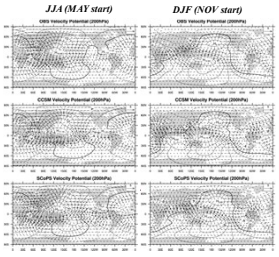
- Initial condition of SCoPS Hindcast simulation
- Restart files of ATM, OCN, ICE

- Hindcast Simulation
  - Total Ensemble members : 10
  - Time lagged forecasting with perturbation ensemble spread by ENKF
  - ATM/OCN/ICE ICs: the 1st, 5th of every month
    - 5 perturbation initial data
  - Hindcast period: 1982~2014 (33 years) / Forecast period: 2015~
  - 7month integration

Results

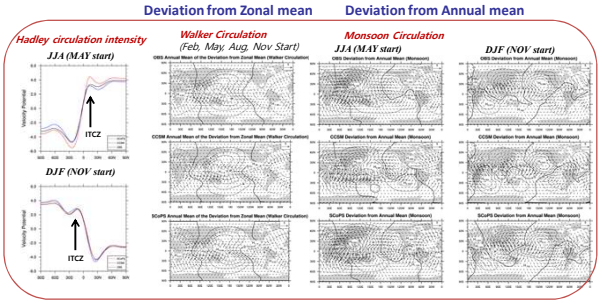
Global / Large-scale fields

200hPa Velocity Potential



Positive(negative): divergence(convergence)

Deviation from Zonal mean / Deviation from Annual mean



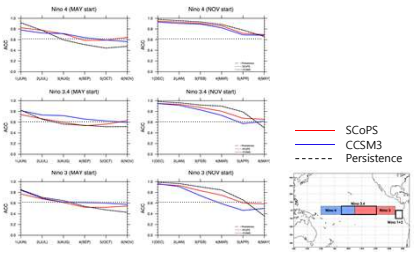
- Following Tanaka et al. 2004, Tellus

- The velocity potential at the 200 hPa level contains information concerning the overall intensity of the tropical circulations of Hadley, Walker and monsoon. These tropical circulations are driven by different dynamical causes. They assume that information is contained in the zonal mean field of the velocity potential. Also, they assume that information on Walker and monsoon circulation is contained in the deviation field from the zonal mean. Secondly, they define the monsoon circulation as part of the seasonal change of the deviation field. Finally, they define Walker circulation as the remainder which is the annual mean of the zonal deviation field. All seasonal cycles were deposited in the monsoon. However, they expect that the present definition retrieves a large fraction of the tropical circulation.

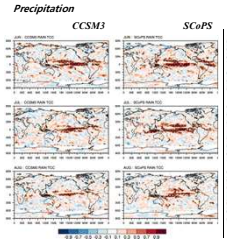
- Forecast skill

- In winter, ACCs of three forecasted Nino indices from SCoPS remain above 0.6 throughout the forecast lead time up to 6 month. This suggests that the ENSO prediction by SCoPS in two seasons ahead should remain useful.
- ACC map of surface air temperature and precipitation from the hindcasts initialized in May and November is shown below. In general, the model prediction for surface air temperature shows a better performance in oceanic area than that over the continental region.

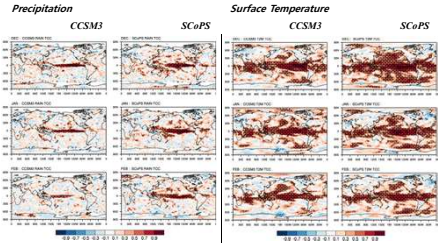
Lead time dependence of the ACC for SST in Nino regions



Prediction skill map in May hindcast

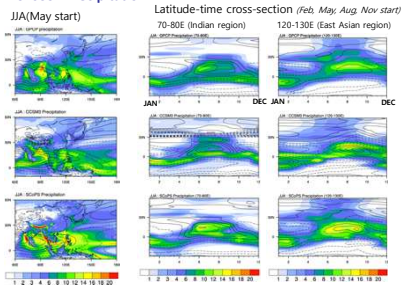


Prediction skill map in November hindcast



Regional / East Asia Summer Monsoon

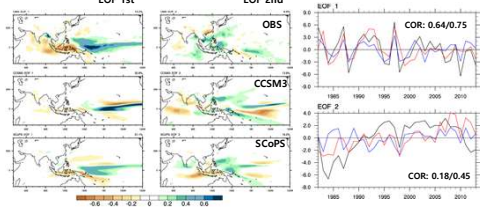
Monsoon Precipitation



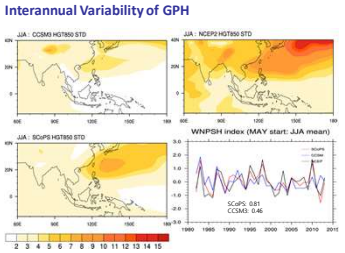
SCoPs exhibits a realistic simulation of the summer monsoon in East Asia, as well as its seasonal evolution.

Seasonal cycle of precipitation and 850 hPa zonal wind at two longitude bands (70-80E and 120-130E) are shown in this figures. As the SCoPS and CCSM3 hindcast runs are available up to 7 months from the initial time, 4 hindcast data from the Feb., May, Aug., Nov. initialized runs were synthesized to examine the complete annual cycle of precipitation and wind.

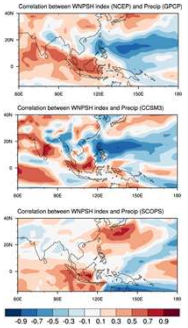
EOF Analysis of precipitation



Interannual Variability of GPH



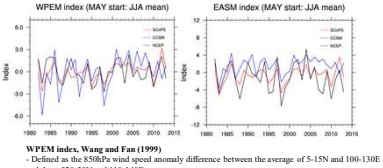
WNPSH index, Wang et al. (2013)
- Defined as the nomalized anomaly of JJA GPH850 over the region of maximum variability (115-150E, 15-25N).



Correlation
SCoPS: 0.69/0.74
CCSM3: 0.44/0.51

- WNPSH is better represented in SCoPS than in CCSM3. This feature is an important driver of Asian summer climate. The interannual variability of JJA 850 hPa geopotential height from the reanalysis with that from the 'May start' in SCoPS and CCSM3. The variability is larger in SCoPS than in CCSM3, bringing it closer to that found in the observational reanalysis. The WNPSH index is defined as the normalized anomaly of JJA GPH850 over the region of maximum variability. The correlation score for this index in SCoPS is 0.81, compared with 0.46 for CCSM3. Also the other indices from zonal wind from SCoPS are higher than those from CCSM3.

East Asia Summer Monsoon Indices



WPEM index, Wang and Fan (1999)
- Defined as the 850hPa wind speed anomaly difference between the average of 5-15N and 100-130E and that of 20-30N and 110-140E.

EASM index, Lee et al. (2014)
- Defined as the 850hPa zonal wind anomaly difference between the average of 5-10N and 130-150E and that of 25-30N and 110-140E.

Summary

- Both CCSM3 and SCoPS well simulate general feature of large-scale climate variability.
- Nino index from both systems show reasonable prediction skill, but SCoPS shows better skill than CCSM3, especially winter season.
- ACC of surface air temperature and precipitation is improved on SCoPS compare to the CCSM3.
- Overall, East Asia Summer Monsoon predictive skills from SCoPS is better than those from CCSM3.

Future issues

Development of Subseasonal to Seasonal (S2S) Prediction system

" Bridging the gap between weather and climate"

- To improve forecast skill and understanding on the subseasonal to seasonal timescale with special emphasis on high-impact weather events
- On the time range between two weeks and a season (e.g. 15-60 days)

Dynamical downscaling

- Application: Water management, Agricultural decision etc.

Effect of the El-Nino Southern Oscillation on Relationship between Arctic Oscillation and Wintertime Temperature over East Asia

Sung-Ho Woo[1], Hyun-Kyung Kim[2], So-Young Yim[2] Jeongwon Park[2] and Seongeun Lee[2]

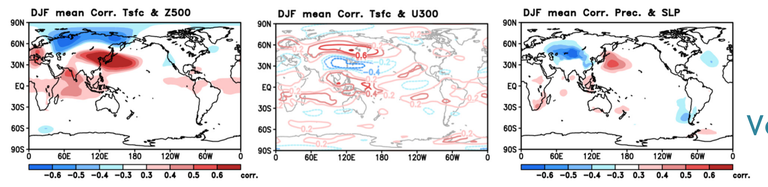
[1]APEC Climate Center, Korea (APCC) and [2]Korea Meteorological Administration (KMA)

Abstract

Our results reveal that the effect of Arctic Oscillation (AO) on the wintertime SAT over East Asia might be modulated by ENSO. In case of the negative (positive) SAT anomaly over East Asia including the Korean Peninsula despite a positive (negative) phase of AO (i.e. uncomplying conditions of the positive correlation between AO and SAT over East Asia), the tropical sea surface temperature shows typical La-Nina (El-Nino)-like pattern. That feature indicates that the ENSO could be main factor modulating the conventional relationship between AO and SAT over East Asia. Actually, in case of the negative (positive) SAT anomaly despite a positive (negative) phase of AO, anomalous downward (upward) motion and strengthening (weakening) of zonal wind over eastern China and the Korean Peninsula are evident. This strengthening of zonal wind associated to the ENSO is favorable condition for deepening of East Asian trough and cold condition over East Asia including the Korean Peninsula. The role of ENSO in the relationship between AO and SAT over East Asia is also supported by the combined effects between AO and ENSO. The composite analysis according to the phases of AO and ENSO reveal that when the AO and ENSO are in-phase (out of phase), the positive relationship between AO and wintertime SAT over East Asia is intensified (weakened).

Background

*** Correlation between SAT over the Korean Peninsula (KP) and Z500/U300/SLP**



East Asian winter monsoon (EAWM)

↓

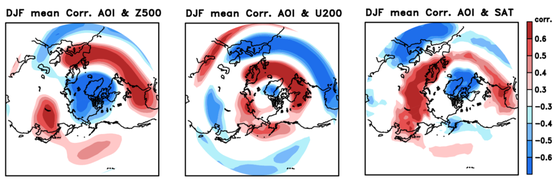
Variation of East Asian ***Surface air temperature (SAT)*** !!

z.B. Warm condition over ***East Asia (EA)*** including ***the Korean Peninsula (KP)*** ….

- Upper-level : Weak East Asian climatological trough & mid-latitude Jet stream
- Lower-level : Weak Siberian high & westward expansion of Aleutian low

→ Weak lower-level northerly wind → Warm condition

Motivation and Objectives



<Correlation between AO and Z500/U300/SAT>

- ***AO (Arctic Oscillation)*** is related to EAWM. (Gong et al. 2001; Li and Yang 2011)
- Correlation value btw. AO and EA SAT : 0.3 ~ 0.4
  - → Variation of EA SAT is not fully explained by AO
  - → Possibility of the other factor modulating relationship between AO and EA SAT

→ What are the main factor affecting the relationship between AO and EA SAT?

→ Combined effect of AO and the factor?

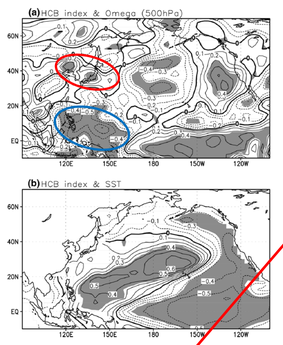
Data and Method

*** Analysis period and Data**

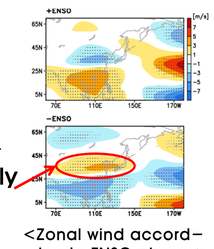
- Periods : 1973-2015 (Boreal winter, Dec. to Feb.)
  (Considered the temporal coverage of observational SAT data over the KP)
- Monthly NCEP/NCAR R1 circulation (U, GPH, omega) and temperature
- Observational SAT data at 45 surface station over the KP

Possible mechanism

*** Park and An (2014)**

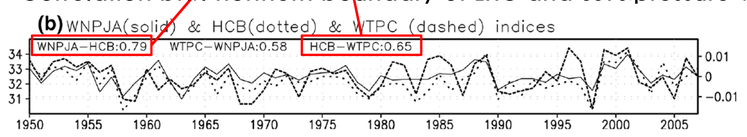


- Convection variation over ***the western Pacific (WP)***
  → Modulation of Hadley & Walker circulation (Gagan & Thompson 2004; Wang et al. 2002)
- Active convection over the WP (LaNina-like SST pattern) & strong downward motion over EA → Northward expansion of Local Hadley cir.(LHC) → Relationship between LHC and meridional movement of Jet → northward movement of Jet → **In perspective of anomaly, strengthening of westerly over EA (especially, near the KP)**



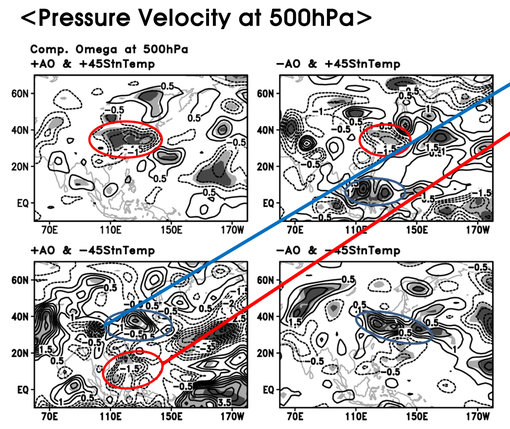
<Zonal wind according to ENSO phases>

<Correlation btw. northern boundary of LHC and SST&pressure velocity>



HCBL: Hadley Cir. Boundary Latitude
WNPJA : Western North Pacific Jet Axis
WTPC : Western Tropical Pacific Convection

<Pressure Velocity at 500hPa>



Downward anomalies

Upward anomalies

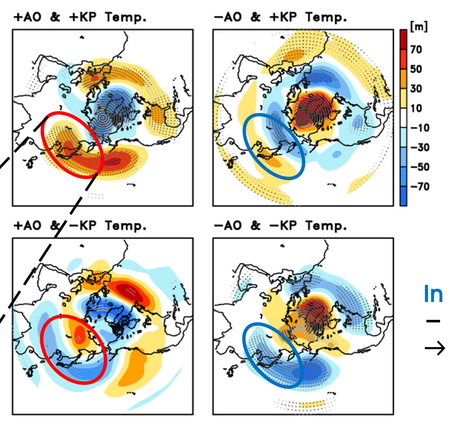
+AO&-Temp : Strengthening of LHC Boundary (northward movement of jet) → downward motion over EA → Intensification of westerly over EA → Favorable condition for cyclonic circulation over EA → Development of EA Trough → Cold condition over EA

ENSO-related convection over the WP & LHC variation from the WP to EA → Modulation of the relation between AO and EA SAT

Modulation of relation btw. AO and East Asian Temperature

***Circulation and SAT fields according to phases of AO and SAT over the KP**

<GPH500>



In +AO&+Temp case,
- EA & Southern Siberia : + GPH ano.

→ Typical +AO-related upper-level cir. pattern

In -AO&+Temp case,
- Northern Siberia : -GPH ano.
- East Asia: +GPH ano.

→ Flattening of EA trough

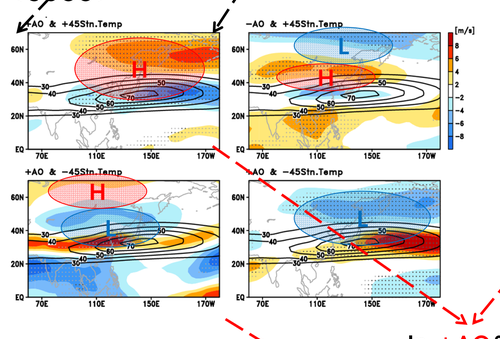
In +AO&-Temp case,
- Northern Siberia : +GPH ano
- East Asia : -GPH ano.

→ Deepening of EA trough

In -AO&-Temp case,
- EA & Siberia : -GPH ano.

→ Typical -AO-related upper-level cir. pattern

<U300>



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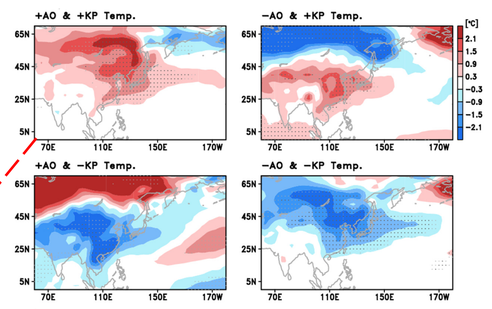


In +AO&+Temp.
: Weakening of East Asian Jet → Its northern part : Anti-cyclonic circulation → Flattening of EA climatological trough → Warm condition over EA

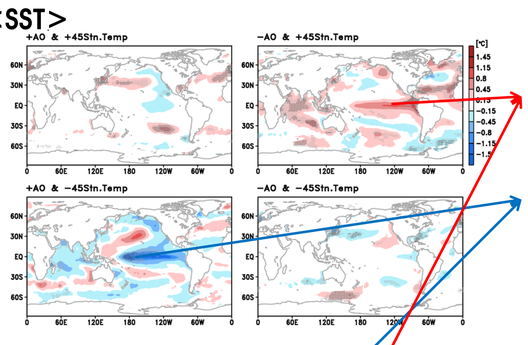
In +AO&-Temp.
: Narrow region over East Asia : strengthening of Jet → Its northern part : Cyclonic circulation □ Deepening of EA climatological trough → Cold condition over EA

※ In +(-)AO&-(+)Temp cases. Noticeable signal from tropic or subtropics

ENSO and Relation btw. AO and East Asian Temperature

***SST and Tropical precipitation fields according to phase of AO and SAT**

<SST>



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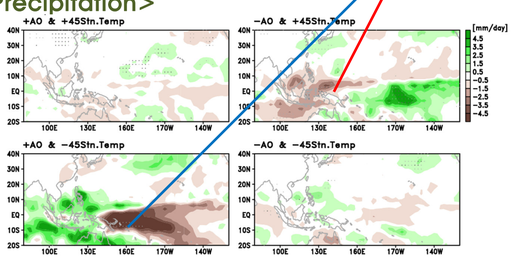


In -AO&+Temp.
: ElNino-like SST & Prec. pattern

In +AO&-Temp.
: LaNina-like SST & Prec. pattern

Tropical convection connected with ENSO → Possibility of modulation of the relation between AO and EA SAT

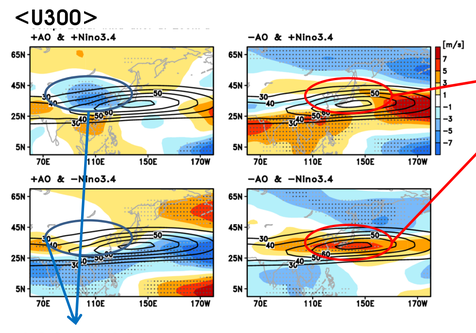
Categories	Cases	Tropical SST
+AO & -KP.Temp.	1975. 12	La-Nina
	1984. 01	La-Nina
	2000. 02	La-Nina
	2008. 02	La-Nina
-AO & +KP.Temp.	1978. 12	El-Nino
	1979. 01	Normal (El-Nino-like pattern)
	1998. 01	El-Nino
	2002. 12	El-Nino
	2004. 02	Normal (El-Nino-like pattern)
	2007. 02	El-Nino
	2010. 01	El-Nino
	2014. 01	Normal (La-Nina-like pattern)

<ENSO phase of Individual case>

Combined effect of AO & ENSO on circulation and SAT

***Circulation and SAT fields according to phases of AO and ENSO**

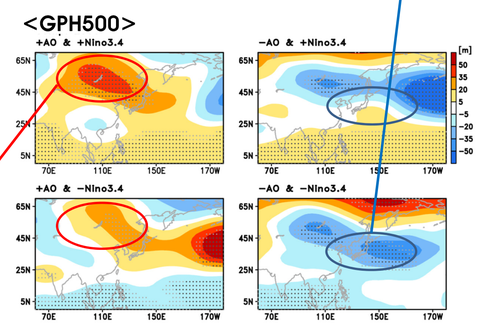
<U300>



-AO&-ENSO : Stronger upper-level zonal wind over EA (KP and Japan)than -AO&+ENSO case

Strong +GPH ano. over that regions (Strengthening of EA trough)

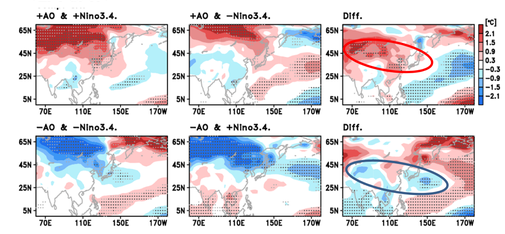
<GPH500>



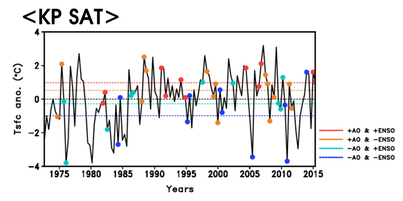
+AO&+ENSO : Weaker upper-level zonal wind than +AO&-ENSO case

Strong +GPH ano. over EA (weakening of EA trough)

<EA SAT>



<KP SAT>



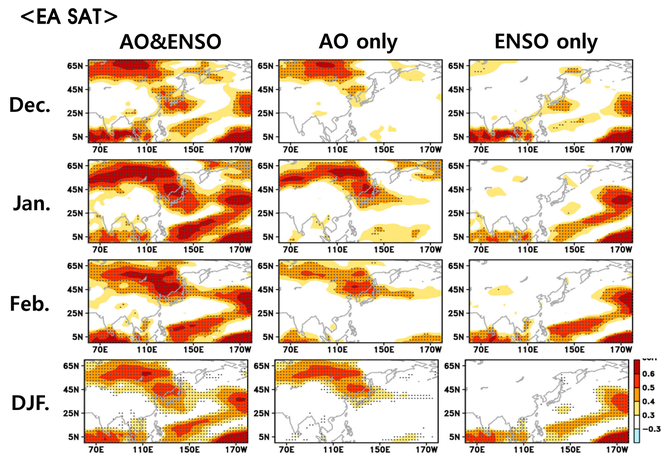
+AO&+ENSO,
: more noticeable +SAT ano. over EA and the KP than in +AO&-ENSO case

-AO&-ENSO,
: somewhat lower SAT ano. over EA and the KP than in -AO&+ENSO case
: But, not as obvious as the difference between +AO&+ENSO and +AO&-ENSO

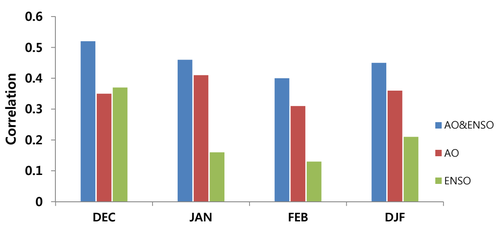
Linear impact of AO & ENSO on SAT variability

*** Correlation between observation and SAT regressed onto AO-ENSO multiple / AO only / ENSO only**

<EA SAT>



<KP SAT>



In case of AO-ENSO multiple,
: better correlation skill than in the others

In Dec. and Feb.,
: Large improvement of correlation skill

Conclusion and Discussion

<Conclusion>

- The AO-EA SAT relationship is affected by ENSO
- ENSO-related convection over the western Pacific and LHC over EA is likely to play an important role in the modulation by ENSO
- This possible linkage is supported by the combined effects of AO and ENSO. When the AO and ENSO are in-phase (out of phase), the positive relationship between AO and wintertime SAT over East Asia is intensified (weakened).

<It is necessary to study on …>

- Phase asymmetry of combined impact AO-ENSO on East Asian circulation and SAT
- A non_linear factor on combined effect of AO and ENSO