문서번호 APCC-출장-17-1588(2017-12-21)

TRAVEL REPORT FORM
출장보고서

결재	선임연구원	팀장	부서장	부서장
	12/20 김유진	12/20 이우섭	12/21 유진호	대결 12/21 김형원
협조	팀장	부서장		
	12/20 조재필	12/20 김형진		

I. Reporter 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측본부 기후예측팀	선임연구원	김유진	12/10-16	개인 사정으로 12월 15일 미국에서 출국함
응용사업본부 응용사업팀	선임연구원	신용희 윤선권	12/10-17	

※ 김광형 팀장은 추가일정으로 개별 출장보고서를 작성할 예정임.

II. Major Activities 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

가. 개요

○ 참가 회의명: American Geophysical Union (AGU) Fall Meeting (11-15, Dec)
- AGU Fall Meeting은 미국 뿐 아니라 전세계 지구과학자들이 일년에 한번 모여 연구를 발표하고 교류를 하는 학술대회로서 지구과학계에서 가장 큰 학술대회 중 하나임
- AGU Fall Meeting에서는 지구과학과 관련된 학계를 망라함. 대기과학, 수문학, 생물학, 농학 뿐 아니라 우주과학, 빙권학, 지구환경학 등의 분야가 포함됨

○ 일시: 2017년 12월 11-15일 (5일간)

○ 장소: New Orleans Earnest N. Morial Convention Center, New Orleans, USA

★ 홈페이지: https://fallmeeting.agu.org/2017/program-overview/

나. 활동

○ 김유진, 신용희, 윤선권 선임연구원, 김광형 팀장이 각자 연구 내용으로 발표하였음. 발표 제목과 내용은 아래와 같음

○ 김유진 발표 (포스터)
- 발표 제목: The development of a statistical seasonal prediction model for the North East Asian summer monsoon rainfall
- 발표 내용: 동북아시아 여름 몬순 강수량의 계절예측을 위한 통계모델을 개발하였음. 동북아시아 여름 몬순을 새롭게 정의하고 이를 예측하기 위한 새로운 통계 모델을 구축하여 현업에 사용할 수 있음. 이 연구는 APEC 기후센터 아태사업 중 “기후예측 활용 기반정보생산” 과제 성과임

- 발표 세션: A31H. Subseasonal to seasonal forecasting of High-Impact Weather and Climate Events Posters
- 발표 일자: 12월 13일 (수) 08:00-12:20

★ 붙임1. 김유진 발표자료

○ 신용희 발표 (포스터)
- 발표 제목: Development of predictive weather scenarios for early prediction of rice yield in South Korea
- 발표 내용: 농진청 수탁과제 "벼 영농정보 및 수량 조기예측을 위한 계절예측 기상 시나리오 생산 및 예측성 평가"의 성과로서 작물모형(ORYZA-200)에 입력되는 예측 기상 시나리오 자료 생산 결과 및 예측성 평가 결과
- 발표 세션: GC33D. Geospatial Methods, Modeling, and Applications of Agricultural Resiliency at Local, Regional, National, and Global Scales II Posters
- 발표 일자: 12월 13일 (수) 13:40-18:00

★ 붙임2. 신용희 발표자료

○ 윤선권 발표 (포스터)
- 발표 제목: Development of a long-range flood risk outlook using seasonal prediction information in South Korea
- 발표 내용: 우니라나 지자체를 대상으로 기후정보를 활용한 통계 역학적 중장기 홍수위험예측을 실시하였으며, 위험도 개념(위해도, 노출도, 취약도)으로 홍수 위험을 해석하여 지자체별 outlook을 제시함. 본 연구는 중장기 홍수위험의 사전예측을 통한 지자체 재난관리에 활용될 수 있음. 본 연구는 APEC 기후센터의 아태 기후정보 서비스의 일환으로 수행되었음
- 발표 세션: H31A. Advances in Characterizing Extreme Storms, Flood Risk, and Flood Risk Management IV Posters
- 발표 일자: 12월 13일 (수) 08:00-12:20

★ 붙임3. 윤선권 발표자료

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

○ 기후과학 및 응용분야 최근 현안 이슈, 국제적 연구 동향 파악함
○ 관련분야 과학자들과의 교류를 통해 인적 네트워크 구축하였음
○ 대기과학, 수자원, 농업 등의 분야에 APCC의 연구 결과를 홍보하였음
○ 전세계에서 관련 학계 과학자들이 모이는 대규모의 학회이니만큼 APCC의 기후과학 및 응용분야 연구 결과를 홍보하는데 적합함

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

1. 윤선권

Abstract ID: 249226

Abstract Title: Development of a long-range flood risk outlook using seasonal prediction information in South Korea

Presentation Type: Poster

Final Poster Number: H31A-1481

Session Title: H31A. Advances in Characterizing Extreme Storms, Flood Risk, and Flood Risk Management IV Posters

Day/Time: Wednesday, 13 December 2017: 08:00 - 12:20, Morial, Poster Hall D-F

2. 김유진

Abstract ID: 270021

Abstract Title: The development of a statistical seasonal prediction model for the North East Asian summer monsoon rainfall

Final Paper Number: A31H-2287

Presentation Type: Poster

Session Date and Time: Wednesday, 13 December 2017; 08:00 - 12:20

Session Number and Title: A31H: Subseasonal to Seasonal Forecasting of High-Impact Weather and Climate Events Posters

Development of a long-range flood risk outlook using seasonal prediction in South Korea

Sunkwon Yoon (skyoon@apcc21.org)
APEC Climate Center, Busan South Korea

APCC APEC CLIMATE CENTER

Introduction

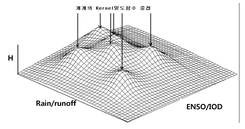
- Floods are one of the most common and frequent natural disaster events in the world.
- In recent years, flood damage has been accelerated due to the effects of global climate change and abnormal climate phenomena.
- With the advancement of technology, enabling to predict of a certain level of climate over various time scales. This called seamless prediction, which is a concept of securing a certain level of predictability from the very short term to climate change.
- Well-known abnormal weather phenomena such as El Niño, La Niña and Indian Ocean Dipole can be used as a main information in determining the long-term variability of water resources.
- Seasonal predictions can serve as a paradigm for the prediction of long-term flood risks, and are increasingly expanding the range of preventive and prepared roles to ensure an effective lead time for long-range flood disasters.

Methodology

Stochastic Approach

Flow Chart of Study

Data and Study Site
↓
Transformation of Hydro-climatic Variables
Principal Component Analysis using SSA
↓
Mutual Information (MI) Techniques
Joint probability density function using Kernel
↓
Linear/Non-linear, Lag Correlations
↓
Teleconnections, Hydro-meteorological Variability, and its local impacts
↓
Trend/Change, Water Resources Management
↓
END



- **Mutual Information(Fraser and Swinney, 1986)**

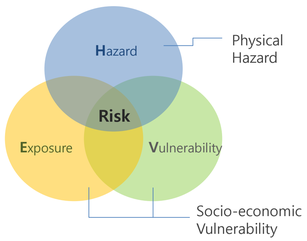
$$MI_{s,q}(s_i,q_j)=\log_2\left(\frac{P_{s,q}(s_i,q_j)}{P_s(s_i)P_q(q_j)}\right)$$

- **Average Mutual Information**

$$I_{s,q}=\sum_{i,j}P_{s,q}(s_i,q_j)\log_2\left(\frac{P_{s,q}(s_i,q_j)}{P_s(s_i)P_q(q_j)}\right)$$

Integrated Flood Risk Assessment

➢ *Integrated Flood Risk Index = f (Hazard, Exposure, Vulnerability)*



$$IFRI=\sum_{i=1}^{l}(h_i\times H_i)+\sum_{j=1}^{m}(e_j\times E_j)+\sum_{k=1}^{n}(v_k\times V_k)$$

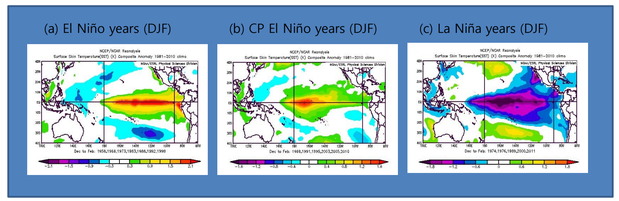
Index Range

Very Low (0.0 - 0.2)
Low (0.2 - 0.4)
Medium (0.4 - 0.6)
High (0.6 - 0.8)
Very High (0.8 - 1.0)

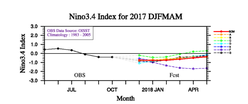
Analysis and Results

New type of El Niño

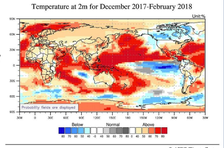
El Niño Modoki
: from the Japanese word meaning "similar, but different"



APCC MME Forecasts

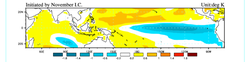


Where is exceptionally heavy rainfall and temperature expected?



What do we do next?

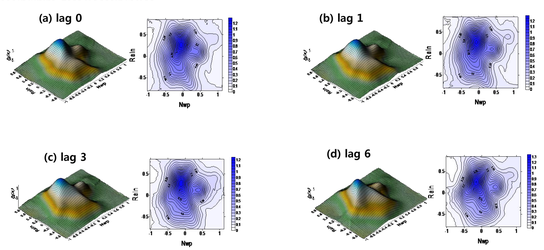
- Contact ...
- Consider ...
- Review ...



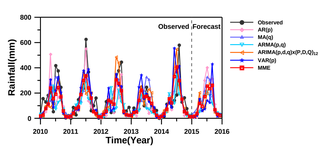
APCC MME Forecasts (http://www.apcc21.net/ser/enso.do?lang=en)

Teleconnections and Time Series Analysis

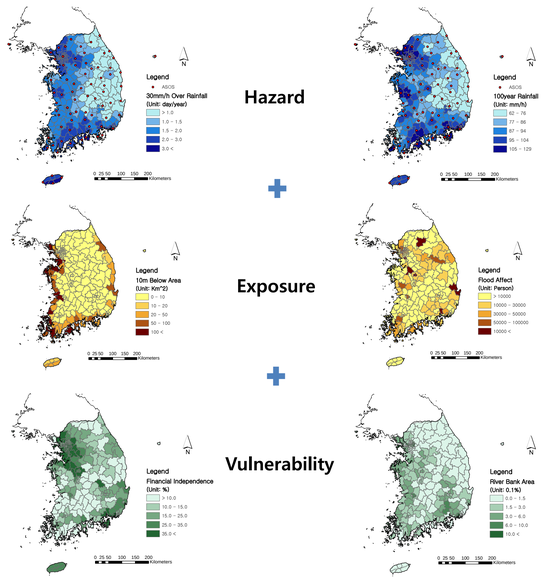
- **Mutual Information**

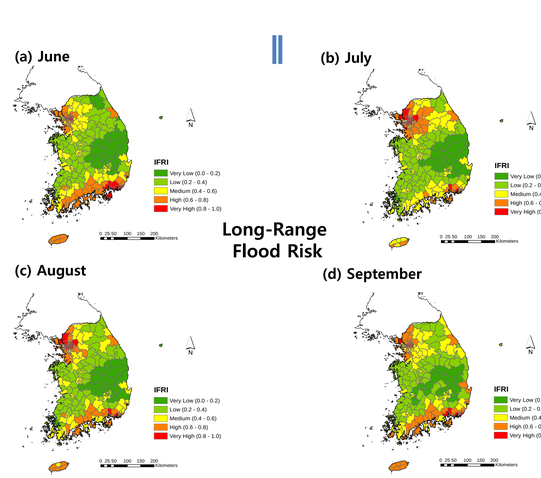


- **Rainfall and ENSO Forecasts**



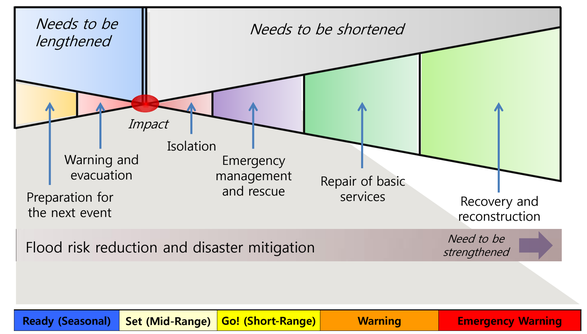
Flood Risk Analysis



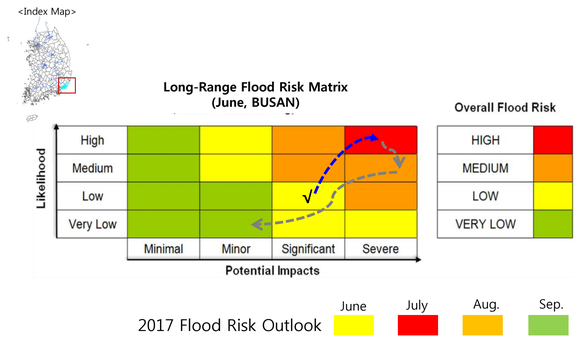


Zonation Map for Combinations of Flood Hazard and Vulnerability for Prediction of Integrated Flood Risk Index (IFRI) during warm season in the Korean 243-local governments: (a) to (d) show IFRI prediction for June to September, respectively.

Disasters Propagation and its Alert Levels



Long-Range Flood Risk Outlook



Conclusions

- Based on the results of this study, several lessons were obtained regarding the enhancement of policy standards and formulation of measures, in order to reduce long-range flood risk in local governments.
- The results of this study are expected to provide useful data for reducing flood risk to stakeholders and decision makers.
- Finally, the long-range flood risk forecasting in local areas can propose the possibility of mid- and long-term planning and forecasting of flood risk for the management of water resources for one to three months of seasonal forecasting information.
- And it can also be used as useful forecasting information for acquisition of lead time in reducing the impacts of disasters such as drought and flood.

The development of a statistical seasonal prediction model for the North East Asian summer monsoon rainfall

Yoojin Kim[1*], MinHo Kwon[2], Sae-Rim Yeo[1]
[1]Climate Prediction Department, APEC Climate Center
[2]Ocean Circulation and Climate Research Division, Korea Institute of Ocean Science and Technology

A statistical seasonal prediction model for the North East Asian summer (June-August) monsoon (NEASM) is developed in this study. The precipitation in the northern part of East Asia [100°-150°E, 15°-50°N] during summer is the forecast target. For this, NEASM is newly defined to represent the precipitation amount and its related physical process which had been rarely focused on in previous studies. Multi-variate empirical orthogonal function analysis based on precipitation and geopotential height is used to define the NEASM and three leading modes are analyzed and predicted. The leading three modes represent the NEASM variation in association with the western Pacific subtropical high; zonal/meridional wave transport from the Eurasian Continent/western Pacific subtropical high; and dipole pattern of air pressures in the Okhotsk Sea and northwestern Pacific, respectively. Through examining physical processes of each mode, three predictors are selected by means of stepwise forward regression method. Then three PCs are predicted by multiple regression equation, separately. The forecast skills (i.e., temporal correlation coefficient) for each mode are 0.82, 0.73, and 0.80 from 1979 to 2011, respectively. Spatial forecast fields are obtained by multiplying predicted PCs and loading vectors of precipitation from observation. In the targeted area, area-averaged temporal correlation coefficient skill of predicted precipitation is 0.36, compared to the observation, which is quite improved from that by only dynamical models.

1. Introduction

The precipitation in the North East Asia (NEA) is concentrated during summer (June-August) due to the nearly east-west-elongated rainbelt built by the North East Asian summer monsoon (NEASM) circulation. The summer rainbelt system is varied along the meridional direction in East Asia (Wang et al., 2008) because some part of rainfall system in the mid-latitude region is affected by the air-mass of the high-latitude as well as those from the low-latitude (Seo et al., 2012). In addition, many low-variable teleconnection climate patterns such as Western Pacific subtropical high (WPSH), ENSO and NAO affects the NEA rainfall system differently from that in the South East Asia (Wang et 2008, Seo et al. 2012). The climate in the mid-latitude region is more difficult to predict in seasonal-scale than that in the low-latitude region by dynamical models (Wang et al., 2013). Thus, the NEASM should be distinguished from the traditional East Asian summer monsoon (EASM) that is focused on the rainfall in the southern part of the East Asia for proper application of seasonal forecast, although the forecast skill of the NEASM would be lower than that of the traditional EASM.

This study aims at defining a new index of the NEASM and seasonal forecast on the NEASM precipitation by statistical methods. In order to predict NEASM, each PC is target, dependently. Predictors are selected from variables which can enforce the evolution of each mode from the world. Many statistical models to predict the traditional EASM had applied topical oceanic forcing, but this study also include the forcing of other boundary variables from mid- and high latitudes.

2. Defining a new index, NEASM

A Multivariate Empirical Orthogonal Function (MEOF) is used to define the target, NEASM. The target of the forecast is the precipitation. Thus, precipitation itself and geopotential height at (GPH) 850-hPa are analyzed to get the target, Principal Components (PCs) of the 'NEASM'. GPH is included to contain the physical mechanisms of the rainfall system. The more variables could be used to define the NEASM as did in the Wang et al. (2008) but we only used two variables to focus the seasonal forecast on the 'rainfall' itself. Three leading modes are target in this study (Figs. 1-3).

- ✓ **MEOF domain: [15°N-50°N, 100°E-140°E]**
- ✓ **Variables: Precipitation [GPCP v.2.2], GPH-850 [NCEP-DOE R2]**
- ✓ **Training period: 1979-2011 JJA mean**
- ✓ **Target modes: 3**

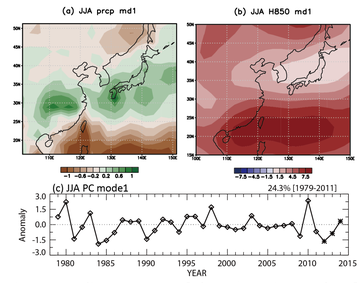


Fig. 1. Loading vectors of the 1st MEOF mode of the East Asian summer (a) precipitation [mm day^{-1}] and (b) 850-hPa GPH [m] anomalies; and (c) corresponding PC time series (unitless).

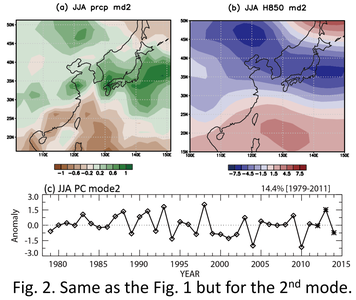


Fig. 2. Same as the Fig. 1 but for the 2nd mode.

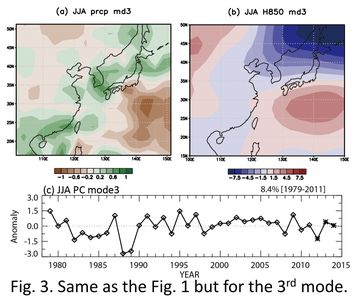


Fig. 3. Same as the Fig. 1 but for the 3rd mode.

3. Selection of predictors

Predictors are selected from the leading correlation maps between each PCs and variables (Figs. 4-6). These correlation maps show evolutionary mechanisms of each NEASM mode.

Among potential predictors (yellow box), predictors are selected (magenta box) through stepwise forward regression to increase forecast skill (TCC). A predictor is defined as a time series of area averaged anomalies those contain only grids exceed a threshold value (0.3) in the corresponding area. Each PC has three predictors (Table 1). These selected predictors are deeply involved in the evolution of each mode.

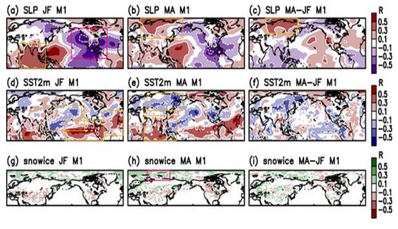


Fig. 4. Leading correlation maps between PCs and variable anomalies: (upper) SLP, (middle) SST/T2m, (lower) snow cover/sea ice. Anomalies of (left) Jan/Feb mean, (center) Mar/Apr mean, and (right) tendency from Jan to Apr are used. Among 9-10 potential predictors (yellow box), 3 predictors (magenta box) are selected.

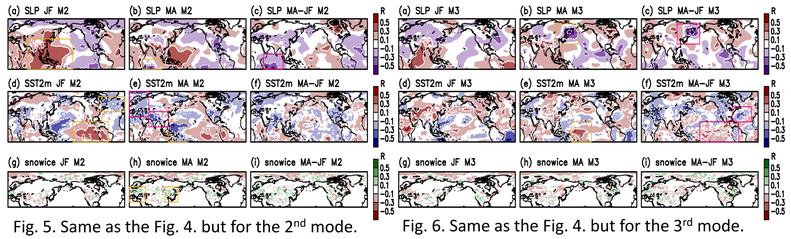


Fig. 5. Same as the Fig. 4. but for the 2nd mode.

Fig. 6. Same as the Fig. 4. but for the 3rd mode.

Table 1. Selected three predictors for PCs. [JF] means Jan/Feb, [MA] means Mar/Apr, and [MA-JF] means tendency from Jan to Mar.

Step	PC1	PC2	PC3
1	[JF] Eastern Pacific SLP	[MA] Europe Temp.	[MA-JF] Eastern Pacific Temp.
2	[MA] Arctic SIC	[MA] Indian Temp.	[MA-JF] Okhotsk Sea SLP
3	[MA-JF] NAO	[MA-JF] Indian Ocean SLP	[MA-JF] North Atlantic SST

4. Prediction

Using three potential predictors, each PC is predicted by multiple regression method (Fig. 7). The forecast skill, TCC are 0.82, 0.73, and 0.80, respectively. In the training period, hindcast data is produced through a leave-three-out cross validation strategy to reduce a over-fitting problem in someway.

Forecast spatial fields are reconstructed after forecast of each PC with loading vectors from real world. This forecast data is compared with observation through TCC (Fig. 8). The area averaged TCC is 0.36 from the new model that is quite reliable and stabilized. Potential maximum TCC through three modes in this region is 0.46 (TCC between observed precipitation and reconstructed fields from observation).

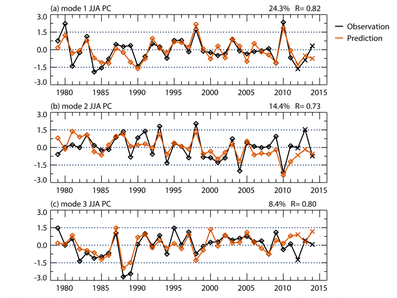


Fig. 7. Predicted time series [orange line] for the (a) 1st, (b) 2nd, and (c) 3rd mode with PCs from observation [black line].

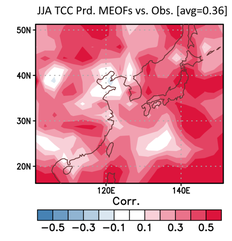


Fig. 8. Map of TCCs between observed precipitation and reconstructed MEOF modes from prediction (1979-2011).

Acknowledgment
This study is supported by the APEC Climate Center.

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