문서번호 APCC-출장-17-0516(2017-05-12)

TRAVEL REPORT FORM
출장보고서

결재	연구원	팀장	부서장	부서장
	05/08 오상명	05/11 이우섭	05/12 유진호	대결 05/12 유진호
협조	팀장	팀장	팀장	부서장
	05/08 김선태	05/10 김광형	05/10 조재필	05/12 김형진

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측본부	선임연구원	김원무	2016.4.22.~2016.4.29	
기후예측본부	선임연구원	민영미	2016.4.24.~2016.4.29	
기후예측본부	선임연구원	이윤영	2016.4.22.~2016.4.29	
기후예측본부	연구원	오상명	2016.4.23.~2016.4.29	
응용사업본부	선임연구원	김대하	2016.4.22.~2016.4.29	
응용사업본부	선임연구원	이승수	2016.4.22.~2016.4.29	
응용사업본부	선임연구원	박경원	2016.4.25.~2016.4.29	
응용사업본부	선임연구원	윤선권	2016.4.22.~2016.4.29	
응용사업본부	선임연구원	이진영	2016.4.22.~2016.4.29	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- 오스트리아 비엔나에서 개최된 “European Geoscience Union General Assembly 2017”에 참석하여 기상, 기후, 농업, 및 수자원과 관련하여 발표 및 토론을 진행함.

가. 학회명 : Eoropean Geoscience Union General Assembly 2017

나. 일정/장소 : 2017.4.23.~2017.4.28. / Austria Center Vienna in Vienna, Austria

다. 발표 제목 및 발표 세션

발표자	발표세션	발표제목
김원무	AS1.1 Numerical weather prediction, data assimilation and ensemble forecasting	Expert-guided hybrid dynamical-statistical seasonal prediction system: An application for the seasonal outlook in Korea
김원무	AS1.24 Dynamical Meteorology (General Session)	Long-term change of the atmospheric energy cycles and weather disturbances
민영미	CL3.01 - Climate Predictions - from	Skill of Real-Time Operational Forecasts with the APCC Multi-Model Ensemble Prediction System for the Period of

	monthly, seasonal to decadal time scales	2008-2015
이윤영	NP4.1/AS4.13/CL5.06 Time Series Analysis, Prediction, Verification and Inter-Comparison of Geoscientific Observations and odel Data (co-organized)	Varied representation of the West Pacific pattern in multiple dynamical seasonal predictions of APCC-MME
오상명	NH1.5/AS4.37/CL4.19/ HS11.27/SM10.9/SSS10 .16 Hazard Risk Management of Agroecosystems and Induced Human Migration (co-organized)	Increasing the highest storm surge in Busan harbor
김대하	HS5.4 Water Resources Management and Policy in a Changing World	Low robustness of increasing reservoir capacity for adaptation to climate change: A case study for an agricultural river basin
이승수	HS7.8 Precipitation and Urban Hydrology	Study on Development of 1D-2D Coupled Real-time Urban Inundation Prediction
박경원	HS7.8 Precipitation and Urban Hydrology	Development of Flood Early Warning System using Remote Sensing Technology
윤선권	HS6.3 Water Level, Storage, floods and Discharge from Remote Sensing and Assimilation in Hydrodynamic models	Development of a multi-sensor based urban discharge forecasting system using remotely sensed data: A case study of extreme rainfall in South Korea
이진영	HS4.4 Drought and water scarcity: monitoring, modelling and forecasting to improve hydro-meteoro	Development of a drought forecasting model for the Asia-Pacific region using remote sensing and climate data: Focusing on Indonesia

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

- 계절예측 모형의 기후 변동성 재현 특성과 관련된 다양한 다중 모형 비교 연구가 진행중임을 확인할 수 있었음.
- 특정 기후 현상(ex, 성층권-대류권 커플링)의 극성에 따라 지표 계절 예측성능이 달라질 수 있음을 확인하였고, 이러한 정보들은 앞으로 센터 내 계절 예측 고도화를 위해 활용될 수 있을 것으로 예상됨.
- 계정예측측면에서는 역학모델 자체 또는 후처리 기술 개발뿐만 계절예측자료를 활용한 application sector 적용을 위한 응용연구가 활발히 진행중임을 확인할 수 있었음(ex, wind energy, agriculture sector).
- Monash 대학의 Evan Welle는 기후모형에서 강수의 변화를 조직확된/국지적인 대류 활동이 지구온난화에 따라 변화하는 양상에 대하여, 조직화된 대류의 강수 빈도는 증가하는 반면 그 강

도는 약화되는 모습을 발견하였음. 이를 검증하는데 사용한 강수대 탐지 기술은 우리 계절 예측 모형이 몬순을 표현하는 성능을 평가하는 가늠자로써 사용될 수 있을 것이라 판단됨. 이에 대하여 예측 담당자 및 SCoPS 팀과 논으해 볼 계획이며, 관련된 코드는 공유해주기로 함.

- 일반적인 통계량을 모의하는 대리 자료 방식에 대한 다양한 정보를 수집할 수 있었고, 반복진폭적용 푸리에 변환(IAAFT)가 다른 방식에 비해 좋은 결과를 생산한다는 것을 재확인 할 수 있었음.
- 태평양에 관한 연구에서는 아열대 및 중위도 대기 순환에 의한 바람의 응력이 태평양의 적도암류 변동성에 크게 기여하는 반면, 적도 순환은 수온약층의 기울기에 상대적으로 중요하게 작용한다는 것을 환인 하였음.
- 위성을 활용한 수위, 유량, 홍수피해 면적등 수자원 분야에 활용할 수 있는 관측 기술 개발에 관한 다양한 연구가 수행되고 있으므로 향후 위성을 활용한 관측과 수리수문 모델을 활용한 예측값의 비교를 통해 모형의 정확도를 향상시킬 수 있는 데이터 확보가 용이해지고 있음.
- 수자원 분야의 경우 전지구 스케일의 수문 모의에 관한 연구가 다양하게 수행되고 있음을 확인할 수 있었으며, 향후 센터에서도 기후자료를 활용한 전지구 수자원 예측과 활용에 관한 연구가 필요할 것으로 판단됨.
- 도시침수 관련된 연구는 상대적으로 적게 수행되고 있었으나, 벨기에 University de Liege의 Benjamin DEWALS 교수가 실시간 도시침수 예측 모형의 개발에 관한 연구에 많은 관심을 표했으며 향후 공동연구를 제안하여 연락 중에 있음.
- ESA Copernicus 사업의 일환으로 발사된 Sentinel 위성을 이용한 홍수, 가뭄에 관한 연구들이 활발하게 진행되었고, 이에 관한 발표가 많았음. 현재 Sentinel 1, 2 위성들이 발사되어 자료를 무료로 수신할 수 있으며, 향후 APCC에서 Sentinel 위성을 기후 연구분야에 응용하면 좋은 연구 결과들이 나올 것으로 판단됨.
- 레이더 자료와 침수모형 결합 홍수 예,경보 시스템에 관한 관심이 많았으며, 향후 적극적으로 해외공동사업으로 제시할 필요성이 있을 것으로 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

European Geosciences Union General Assembly 2017

Vienna | Austria | 23–28 April 2017

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Aims & scope

The EGU General Assembly 2017 will bring together geoscientists from all over the world to one meeting covering all disciplines of the Earth, planetary and space sciences. The EGU aims to provide a forum where scientists, especially early career researchers, can present their work and discuss their ideas with experts in all fields of geoscience. The EGU is looking forward to cordially welcoming you in Vienna.

Note on hotel reservations

Please note that the congress ECCIMD2017 (10,000 participants) will take place in Vienna at the same time as the EGU2017. In addition, the Vienna City Marathon (40,000 participants) will take place on Sunday, resulting in many hotels being fully booked the night before. Therefore, we strongly recommend booking accommodation as soon as possible.

News

- **Abstract submission (deadline: 11 Jan 2017, 13:00 CET)**
- **Short course request (deadline: 20 Jan 2017)**
- **Townhall meeting request (deadline: 20 Jan 2017)**
- **Sponsorship opportunities (for exhibitors only, deadline: 1 March 2017)**
- **Splinter meeting request**
- **Pre- & post-assembly activities**

Low robustness of increasing reservoir capacity for adaptation to climate change: A case study for an agricultural river basin

Daeha Kim[1], Hyung-Il Eum[1]

[1]Climate Application Department, APEC Climate Center, Busan, South Korea

Abstract

With growing concerns of the uncertain climate change, investments in water infrastructures are considered as adaptation policies for water managers and stakeholders despite their negative impacts on the environment. Particularly in regions with limited water availability or conflicting demands, building reservoirs and/or augmenting their storage capacity were already adopted for alleviating influences of the climate change. This study provides a probabilistic assessment of climate change impacts on water scarcity in a river system regulated by an agricultural reservoir in South Korea, which already increased its storage capacity for water supply. For the assessment, we developed the climate response functions (CRFs) defined as relationships between bi-decadal system performance indicators (reservoir reliability and vulnerability) and corresponding climatic conditions, using hydrological models with 10,000-year long stochastic generation of daily precipitation and temperatures. The climate change impacts were assessed by plotting 52 downscaled climate projections of general circulation models (GCMs) on the CRFs. Results indicated that augmented reservoir capacity makes the reservoir system more sensitive to changes in long-term averages of precipitation and temperatures despite improved system performances. Increasing reservoir capacity is unlikely to be “no regret” adaptation policy for the river system. On contrary, converting the planting strategy from transplanting to direct sowing

(i.e., a demand control) could be a more robust to bi-decadal climatic changes based on CRFs and thus better for adaptation with no regret.

Long-term change of the atmospheric energy cycles and weather disturbances

WonMoo Kim[1,2] and Yong-Sang Choi[2,3,4]

[1]Climte Research Team, Climate Prediction Department, APEC Climate Center, Busan, Korea

[2]Center for Climate/Environmental Change Prediction Research, Ewha Womans University, Seoul, Korea

[3]Department of Atmospheric Science and Engineering, Ewha Womans University, Seoul, Korea

[4]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

Weather disturbances, including extreme weather phenomena, are the manifestation of mean atmospheric energy cascading into eddies. In this regard, the quantitative assessment of the atmospheric energy structure is a key to understand the weather variability in a changing climate. Whether our observational reanalysis data can lead to a consistent diagnosis on the energy conversion characteristics is thus an interesting question. Here we investigate the atmospheric energy cascades by a simple framework of Lorenz energy cycle, and analyze the energy distribution in mean and eddy fields as forms of potential and kinetic energy. Two widely utilized independent reanalysis datasets, NCEP-DOE AMIP-II Reanalysis (NCEP2) and ERA-Interim (ERA-INT), are selected for the analysis. Both datasets generally agree with the energy distribution and their conversion characteristics; however, they draw different conclusions on the change of weather variability measured by eddy-related kinetic energy. NCEP2 shows an increased mean-to-eddy energy conversion and enhanced eddy activity due to efficient baroclinic energy cascade, but ERA-INT shows relatively constant energy cascading structure between the 1980s and the 2000s. The source of discrepancy mainly originates from the uncertainties in hydrological variables in the mid-troposphere that links dynamics and physics. Therefore, a reliable diagnosis of the weather disturbances and their change as a consequence of man-made greenhouse effect require much improvement in the mid-tropospheric observations.

Expert-guided hybrid dynamical-statistical seasonal prediction system: An application for the seasonal outlook in Korea

WonMoo Kim[1], Sae-Rim Yeo[2], and Yoojin Kim[2]

[1]Climte Research Team, Climate Prediction Department, APEC Climate Center, Busan, Korea

[2]Climte Prediction Team, Climate Prediction Department, APEC Climate Center, Busan, Korea

An Expert Seasonal Prediction System for operational Seasonal Outlook (ESPreSSO) is developed based on APEC Climate Center (APCC) Multi-Model Ensemble (MME) dynamical prediction and expert-guided statistical downscaling techniques. Dynamical models have improved to provide meaningful seasonal prediction, and their prediction skills are further improved by various ensemble and downscaling techniques. However, experienced scientists and forecasters make subjective correction for the operational seasonal outlook due to limited prediction skills and biases of dynamical models. Here, a hybrid seasonal prediction system that grafts experts' knowledge, experience, and understanding onto dynamical MME prediction is developed to guide operational seasonal outlook. The system will operate under the following assumptions: a) dynamical models have some prediction skills, whether or not they are systematically biased, b) target variables are dynamically homogeneous enough to be controlled by similar processes, but heterogeneous enough to generate diversity in potential predictors, and c) experts have keen knowledge on observed dynamics, model performance, and ESPreSSO. The basis dynamical prediction is based on the APCC MME, which are statistically mapped onto the station-based observations by experienced experts. Their subjective selection undergoes objective screening and quality control to generate final seasonal outlook products after physical ensemble averaging. The prediction system is constructed based on 23-year training period of 1983–2005, and its

performance and stability is assessed for the independent 11-year prediction period of 2006–2016.

Skill of Real-Time Operational Forecasts with the APCC Multi-Model Ensemble Prediction System for the Period of 2008-2015

Young-Mi Min[1*], Vladimir N. Kryjov[1], Sang Myeong Oh[1], Hyun-Ju Lee[1]

[1]*APEC Climate Center, Busan, Republic of Korea*

This paper assesses the real-time one-month lead forecasts of three-month (seasonal) mean temperature and precipitation on a monthly basis issued by the Asia-Pacific Economic Cooperation (APEC) Climate Center (APCC) for 2008-2015 (8 years, 96 forecasts). It shows the current level of the APCC operational multi-model prediction system performance. The skill of the APCC forecasts strongly depends on seasons and regions that it is higher for the tropics and boreal winter than for the extratropics and boreal summer due to direct effects and remote teleconnections from boundary forcings. The forecast skill for temperature is generally higher than that f precipitation. The APCC operational probabilistic forecasts during this period show a cold bias (underforecasting of above-normal temperature and overforecasting of below-normal temperature) underestimating a long-term warming trend. A wet bias is evident for precipitation, particularly in the extratropical regions. The skill of both temperature and precipitation forecasts strongly depends upon the ENSO strength. Particularly, the highest forecast skill noted in 2015/16 boreal winter is associated with the strong forcing of an extreme El Nino event. Meanwhile, the relatively low skill is associated with the transition and/or continuous ENSO-neutral phases of 2012-14. In general, the skill of the real-time forecasts is close to that of historical ones. The regions, featuring the high skill of seasonal forecasts, feature lower interseasonal variability of skill characteristics than the regions of low skill.

Increasing the highest storm surge in Busan harbor

Sang Myeong Oh[1], Il-Ju Moon[2], and Suk Jae Kwon[3]

APEC Climate Center[1],

Typhoon Research Center, Jeju National University[2],

Korea Hydrographic and Oceanographic Administration[3]

One of the most pronounced effects of climate change in coastal regions is sea level rise and storm surges. Busan in particular, the fifth largest container handling port in the world, has suffered from serious storm surges and experienced a remarkable mean sea level (MSL) rise. This study investigates a long-term variation of annual maximum surge height (AMSH) using sea level data observed in Busan over 53 years (1962~2014). The decomposition of astronomical tides and surge components shows that the AMSH has increased 18 cm over 53 years (*i.e.*, 3.5 mm/year), which is much larger than the MSL trend (2.5 mm/year) in Busan. This significant increase in AMSH is mostly explained by the increased intensity of landfall typhoons over the Korean peninsula (KP), which is associated with the increase of sea surface temperature and the decrease of vertical wind shear at mid-latitudes of the western North Pacific. In a projected future warming environment, the combination of an increasing MSL and AMSH will accelerate the occurrence of record-breaking extreme sea levels, which will be a potential threat in Busan harbor.

HS4 – Hydrological Forecasting

HS4.1 Flash floods and associated hydro-geomorphic processes: observation, modelling and warning

Study on Development of 1D-2D Coupled Real-time Urban Inundation Prediction model

Seungsoo Lee(Seungsoo_lee@apcc21.org)[1]

[1] APEC Climate Center, Busan, Republic of Korea

ABSTRACT

In recent years, we are suffering abnormal weather condition due to climate change around the world. Therefore, countermeasures for flood defense are urgent task.

In this research, study on development of 1D-2D coupled real-time urban inundation prediction model using predicted precipitation data based on remote sensing technology is conducted. 1 dimensional (1D) sewerage system analysis model which was introduced by Lee et al. (2015) is used to simulate inlet and overflow phenomena by interacting with surface flown as well as flows in conduits. 2 dimensional (2D) grid mesh refinement method is applied to depict road networks for effective calculation time. 2D surface model is coupled with 1D sewerage analysis model in order to consider bi-directional flow between both. Also parallel computing method, OpenMP, is applied to reduce calculation time. The model is estimated by applying to 25 August 2014 extreme rainfall event which caused severe inundation damages in Busan area in Korea. Oncheoncheon basin is selected for study basin and observed radar data are assumed as predicted rainfall data.

The model shows acceptable calculation speed with accuracy. Therefore it is expected that the model can be used for real time urban inundation forecasting system to minimize damages.

Varied representation of the West Pacific pattern in multiple dynamical seasonal predictions of APCC-MME

Yun-Young Lee

Climate Prediction Team, Climate Prediction Department, APEC Climate Center, Busan, Korea

West Pacific (WP) teleconnection pattern is one of the well-known primary modes of boreal winter low-frequency variability (LFV) resolved in 500 hPa geopotential height and its phase and amplitude strongly influence regional weather conditions including temperature and rainfall extremes [Baxter and Nigam, 2015; Hsu and Wallace, 1985; Linkin and Nigam, 2008; Mo and Livezey, 1986; Thompson and Wallace, 1998; Wallace and Gutzler, 1981]. This study primary aims to evaluate individual 11 GCMs seasonal hindcasts employed as members of multi-model ensemble (MME) produced in APEC Climate Center (APCC) in representing WP. For the extensive and comprehensive evaluation, this study applied seven verification metrics in three scopes: (a) temporal representation of observed indices, (b) spatial mode separation in the Northern Hemisphere (NH), and (c) regional mode isolated in the preset longitudinal domain. Verification results display quite large inter-model spread. Some models mimic observed index variability while others display large bias of index variability compared to climatology. Basic north-south dipole pattern is mostly well reproduced in both rotated and unrotated loading modes. However, each individual seasonal forecast model exhibits slightly different behavior (e.g. amplification/weakening, zonal and meridional shift, downstream extension and so forth) in representing spatial structure of WP. When taking all 7 metrics into account, one Europe (CMCC) model, one Oceania (POAMA) model and two North America (NASA and NCEP) models are classified as relatively good performers while PNU is classified as a matchless poor performer out of 11. Least WP representing skill of PNU is sort of consistent with the largest bias of NH total variability.

This study further tries to examine winter mean biases of individual models and to figure out how mean bias is linked to WP representation in model world. Model bias of winter climatology is investigated focusing on six large scale phenomena: East Asian winter monsoon (EAWM), Atlantic dipole, Pacific/Atlantic jets and Pacific/Atlantic Hadley circulations. Changes in structure and amplitude of them are diagnosed in terms of root mean square error, pattern correlation, intensity bias, zonal displacement and/or downstream extension. There is consistent strengthening/downstream extension of Atlantic jet and absence of southern divergence cell of Atlantic Hadley in most seasonal prediction models. It is demonstrated that WP representation has something to do with bias of Atlantic winter climatology (Atlantic dipole and Atlantic jet) from scatter plot and regression analysis. This implies the importance of realistic simulation of winter climatology further upstream for better WP representation. A fundamental conclusion of this study is that the representation of primary WP features varies among individual models of APCC-MME and it is significantly dependent on the deficiencies of some winter mean climatological patterns.

HS4 – Hydrological Forecasting

HS4.4 Drought and water scarcity: monitoring, modelling and forecasting to improve hydro-meteorological risk management

Development of a drought forecasting model for the Asia-Pacific region using remote sensing and climate data: Focusing on Indonesia

Jinyoung Rhee (jyrhee@apcc21.org)[1], Gayoung Kim (chorong@apcc21.org)[1], and Jungho Im (ersgis@unist.ac.kr)[2]

[1] APEC Climate Center, Busan, Republic of Korea

[2] Ulsan National Institute of Science and Technology (UNIST), Ulsan, Republic of Korea

ABSTRACT

Three regions of Indonesia with different rainfall characteristics were chosen to develop drought forecast models based on machine learning. The 6-month Standardized Precipitation Index (SPI6) was selected as the target variable. The models' forecast skill was compared to the skill of long-range climate forecast models in terms of drought accuracy and regression mean absolute error (MAE).

Indonesian droughts are known to be related to El Nino Southern Oscillation (ENSO) variability despite of regional differences as well as monsoon, local sea surface temperature (SST), other large-scale atmosphere-ocean interactions such as Indian Ocean Dipole (IOD) and Southern Pacific Convergence Zone (SPCZ), and local factors including topography and elevation. Machine learning models are thus to enhance drought forecast skill by combining local and remote SST and remote sensing information reflecting initial drought conditions to the long-range climate forecast model results.

A total of 126 machine learning models were developed for the three regions of West Java (JB), West Sumatra (SB), and Gorontalo (GO) and six long-range climate forecast models of MSC_CanCM3, MSC_CanCM4, NCEP, NASA, PNU, POAMA as well as one climatology model based on remote sensing precipitation data, and 1 to 6-month lead times.

When compared the results between the machine learning models and the long-range climate forecast models, West Java and Gorontalo regions showed similar characteristics in terms of drought accuracy. Drought accuracy of the long-range climate forecast models were generally higher than the machine learning models with short lead times but the opposite appeared for longer lead times. For West Sumatra, however, the machine learning models and

the long-range climate forecast models showed similar drought accuracy. The machine learning models showed smaller regression errors for all three regions especially with longer lead times.

Among the three regions, the machine learning models developed for Gorontalo showed the highest drought accuracy and the lowest regression error. West Java showed higher drought accuracy compared to West Sumatra, while West Sumatra showed lower regression error compared to West Java. The lower error in West Sumatra may be because of the smaller sample size used for training and evaluation for the region. Regional differences of forecast skill are determined by the effect of ENSO and the following forecast skill of the long-range climate forecast models. While shown somewhat high in West Sumatra, relative importance of remote sensing variables was mostly low in most cases. High importance of the variables based on long-range climate forecast models indicates that the forecast skill of the machine learning models are mostly determined by the forecast skill of the climate models.

Development of Flood Early Warning System using Remote Sensing Technology

Heavy rainfall is the most devastating natural hazards in Korea peninsular As a result, Monitoring and forecasting of heavy rainfall is one of important challenges for flash floods in accurate rainfall estimation. The precipitation from satellite is very effective for flash floods. Geostationary satellite is especially important for estimating and predicting heavy rainfall in high time and spatial resolution during flash flood by Typhoon. This study validated rainfall algorithm for typhoon Chaba using Korea geostationary satellite images and GPM(Global Precipitation Misssion) DPR(Dual Precitation Radar) and GMI(GPM Microwave Imager) sensors. We makes algorithm co-located GPM Level 2 precipitation with rain flag, precipitation type flag, land/ocean flag, convective/stratiform flag, cloud top height flag and COMS geostationary satellite 5 channels. This algorithm can be applied to Himawari 8 satellite with more than 3 times as time resolution and 2 times spatial resolution comparison with COMS satellite. This paper describes improvement of application of accuracy in rainfall estimation by Himawari 8 satellite additional spectral bands.