문서번호 APCC-출장-18-1131(2018-11-21)

결재	선임연구원	팀장	부서장	원장직무대행
	11/21 정유란	11/21 신용희	11/21 유진호	11/21 유진호
협조				

TRAVEL REPORT FORM
출장보고서

I. Travel Overview 출장개요

1. Traveler(s) 출장자

Department 소속	Position 직위(직급)	Name 성명	Note 비고
융합기술팀	선임연구원	정유란	

2. Travel Period 출장기간

기간: 2018년 11월 3일-9일

3. Occasion and destination 행사 및 출장지

학회명: 2018 ASA, CSSA, & SSSA International Annual Meetings

장소: 미국 메릴랜드주 볼티모어 컨벤션 센터 (Foto 1)

목적: 상세화된 겨울 계절 기후예측 자료로부터 겨울 작물의 생육 및 생산성 예측 불확실성 및 활용 가능성 평가 결과를 발표. 농업환경 및 생산성 예측에 타겟 계절에 따른 예측기후와 상세화 및 활용 기술 (예, 농업기후정보의 국지적 적용방법 등) 발표

II. Major Activities 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

(1) ASA session의 Climatology and Modeling session 발표:

- 세션: Climatology and Modeling Session
- 일시: 11월 7일 (수), 14:30-16:00
- 제목: Exploring of utilization of seasonal forecast climate information to the crop model: a case study of Korean winter barley (첨부 1과 첨부 2)
- 내용:
  - ▪ 상세된 계절 예측기후를 작물모형과 결합, 겨울보리의 생육 및 생산 예측 활용 가능한 사례를 소개하고 그 예측 불확실성 평가 방법을 발표하였음 (Foto 2).
  - ▪ 특히, 센터에서 개발한 상세 기법에 의한 겨울 계절의 특성을 작물의 재배 타겟 기간에 맞추어 확률적 예측 불확실성을 평가한 결과를 발표하였음.

(2) ASA session의 Climatology and Modeling Session 참석:

- 일요일 체크인 및 리셉션: Opening Keynote에서 Dr. Jules Pretty (교수)는 기후변화에 대한 농촌 경제의 적응 및 완화를 위한 redesign에서 SI (sustainable intensification)는 중요한 역할인데, 농업 지식 공유를 기반한 공동 가치 활동 (Co-creation of agricultural knowledge economies)이 SI를 가능하게 할 것이라고 했으며 관련 공동 연구사례를 보여주었음.
- 월요일 심포지엄 (The Modeling Road Less Travelled-Alternative Paradigms for Crop Modeling, 5 Nov., Mon.)에서는 geno type (pheno type) 연구에 작물모형 앙상블 시뮬레이션 도입 가능성 및 새로운 접근 방법의 필요하다고 결론. 미기상학적 (시설 환경을 의미) 환경에서 식물의 growth and development를 3차원 시뮬레이션 및 제어 사례를 보여줬음. 예를 들면, 수분스트레스 (예, 가뭄)에 따른 3차원 잎출현 속도, 엽활성 (예, 잎의 발육 상태) 및 엽면적 시뮬레이션 결과였음.
- 화요일 심포지엄 (Future of Remote Sensing for Agriculture: How This information Can be Effectively Used for Decision Making. 6 Nov.)에서는 다양한 가용할 수 있는 정보들, 예를 들면 최근 생산되고 있는 고해상도 위성영상자료의 결합 연구 사례였음. 또한 육종학 측면에서 작물모형의 역할과 다양한 실험 자료의 결합 및 접근법 (예, deep learning 등)에서 발생하는 수량 예측 문제 등에 대한 논의도 하였음.

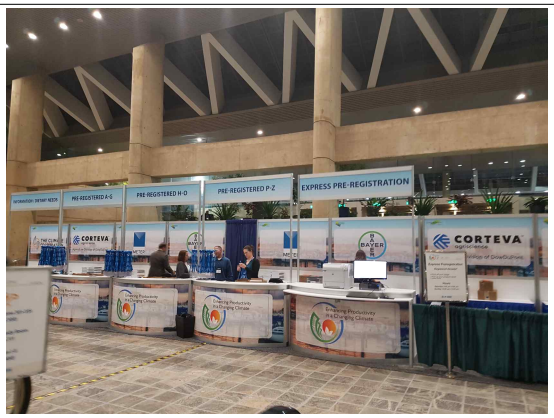
  ※ Dr. Sanai Li가 (Trends in addressing knowledge gaps in Crop modeling Session에서) GLAM-rice을 이용해서 남한 지역 쌀 생산량 예측한 결과를 발표했으며, 질문이 없어 moderator가 대표로 계절 예측 활용에 대한 다음 후속 연구와 관련된 것이 있느냐고 질문했음(그렇게 기억됨).
- 수요일 심포지엄 (Exploring G x E x M Synergies in World-Wide Wheat. 7 Wed)에서는 전 세계에 걸친 밀 실험 자료와 모형을 결합하여 적합한 품종을 뽑아내고 해당 품종의 예측 및 불확실성을 설명할 수 있는 환경들에 대한 분석/설명 사례들에 대한 논의였음.

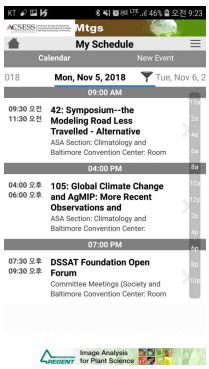
(3) DSSAT group meeting 참석:

- 일시: 11월 5일 (월), 19:30-21:00
- 내용:
  - ▪ 작물모형 개발자에서부터 사용자에 이르기까지 관련 저널 정보와 자료 활용에 대한 최신 연구 정보들을 소개하고 논의하였음.
  - ▪ 특히 DSSAT 4의 C++ 기반의 후세대 버전(영: NextGen) 개발 관련 논의.
  - ▪ 또한 DSSAT/AgMIP steering member의 진행 중인 프로젝트들에서부터 개발하고 있는 작물모형들에 대한 여러 자료 공유 및 소개 (예, GitHub 등) 방법에 대해 논의하였음.
  - ▪ 국제쌀연구소와 미국 플로리다 대학에서 진행 중인 작물 유전모수와 모델링 관련 연구 활동과 CGIAR의 농업 빅데이터 플랫폼 논의가 이슈였음.
  - ▪ 2019년에 진행될 훈련 프로그램 및 미팅, 그 외 지역들에서 소소하게 진행되는 DSSAT과 관련된 연구 활동에 대한 소식들에 대한 소개와 논의가 있었음.

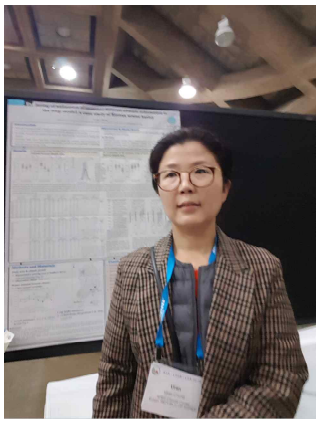
2. Relevance to APEC Climate Center's Activities 결론 및 소감

- 출장자 발표에서, 많은 연구자들이 관심을 보였음. 계절 예측 상세화 과정 및 그것의 작물모형 활용 및 평가 과정에 대한 질문을 많이 받았음.
- 이에 센터 기후예측 자료의 농업모형 활용/예측 및 평가 결과를 지속적으로 발표하고 공유할 필요가 있음을 느낌.





<Foto 1. ASA CSSA SSSA Check-In: (top) registration desk, (left) and (right) meeting scheudles in App - save paper>



<Foto 2. Presenstation>

※ 등록할 때, no proceeding option 선택-MyASA App을 이용해서 스케쥴 관리했음. 또한 (check-in) 참석자들에게 메시지 전달 기능을 이용하여 참석자들과 소통 가능.

3. Suggestions and Remarks 건의사항

III. References (Presented and Collected Materials) 주요 수집자료

(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

Exploring of utilization of seasonal forecast climate information to the crop model: a case study of Korean winter barley

Abstract

Winter seasonal forecast weather information (e. g., temperature and precipitation) for 1988 to 2013 of Jinju and Milyang where are the representative cultivation areas of winter barley in Nakdong River basin, were generated respectively from the statistical model of multi-site weather generator according to the nine conditions of normal (normal), or lower than normal (below), or higher than normal (above). The growth and development model for barley, CERES-Barley was run with these weather data to estimate heading date and potential yield of winter barley during the period. The predicted heading time was expected to be reduced by -14% averagely at higher predicted seasonal temperature than normal and to be delayed by 4% than the heading time simulated from the observation. When predicted seasonal precipitation is high at higher seasonal temperatures than normal, it is expected that the predicted potential yield change is 17%, and if the predicted seasonal temperature is higher than normal, the predicted potential yield change increases to 31% compared with the potential yield estimated from the observation. In the probability density function (PDF) according to the below, normal, and above conditions of the seasonal predicted climate information, the predicted heading time reproduced similarly around the heading time simulated from the observation. However, the predicted potential yield estimated by seasonal forecast climate was out of the distribution and range of the potential yield simulated from the observed climate in the probability density distribution and was also over estimated. If the input parameters of CERES-Barely, such as genetic parameters of barley, soil parameters or management information and so on are improved, it can be expected that the utilization of seasonal predicted climate information can be enhanced to predict the potential yield of barley in the crop model.

Key words: winter seasonal forecast, downscaling, winter barley, crop model, uncertainty, predictability

Acknowledgement: This research was supported by the APEC Climate Center for Climatic Information Services.

Exploring of utilization of seasonal forecast climate information to the crop model: a case study of Korean winter barley

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Introduction

- Seasonal forecasts predict changes in the possibility of climate events that can occur for a minimum duration of a month to a maximum duration of six months.
- Recently, research on seasonal forecasts has been actively conducted in Korea and abroad.
- However, there have also been concerns about the accuracy and uncertainty of seasonal forecast climate at multi-range scales, as well as the possibility of applying these forecast to various fields.

Objectives & Study Areas

- Studies on the application of downscaled S2S and seasonal forecasting data for crop modelling are rare in Korea.

In this study,

- Seasonal forecast climatic data of Nakdong river basin was generated by multi-site weather generator based on statistical methods was input to the crop model for prediction of winter barley growth and potential yield and its application possibility for the prediction of crop growth response changes were examined.

Results

I. Evaluation of the heading day of barley predicted by winter seasonal forecast climatic data

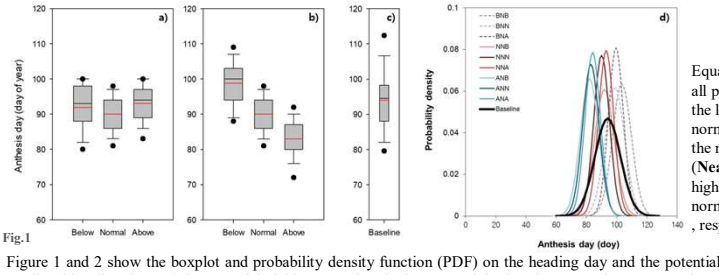

Fig.1

Equally in the all panels, the lower than normal (**Below**), the near normal (**Near**), and the higher than normal (**Above**) , respectively.

II. Evaluation of the potential yield of barley predicted by winter seasonal forecast climatic data

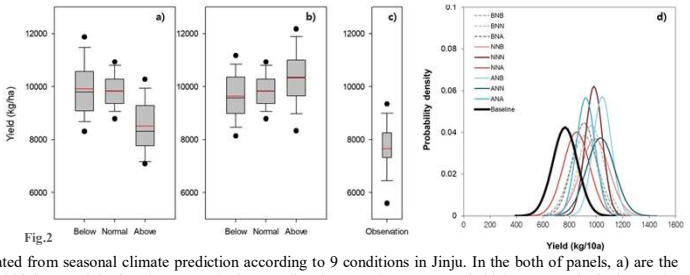

Fig.2

Figure 1 and 2 show the boxplot and probability density function (PDF) on the heading day and the potential yield estimated from seasonal climate prediction according to 9 conditions in Jinju. In the both of panels, a) are the predicted heading day and the potential yield averaged at the lower precipitation than normal, near normal precipitation, and higher precipitation than normal when predicted seasonal temperature is higher, respectively. b) are the predicted heading day and the potential yield averaged at three conditions such as the lower temperature than normal, near normal temperature, and higher temperature than normal when predicted seasonal precipitation is higher, respectively. c) is the observed heading day and the observed yield as a reference, respectively. d) explain the PDF of the predicted heading days of 9 scenarios based on inter-annual variety. Baseline of d) present observation heading day and yield, like c).

The predicted heading time reproduced similarly around the heading time simulated from the observation. the predicted potential yield estimated by seasonal forecast climate was over estimated and also out of the distribution and range of the potential yield simulated from the observation in PDF.

	Normal Climate (1981-2010) (°C)			Average ANT vs. ANP-NNP-BNP (°C)			Average ANP vs. ANT-NNT-BNT (°C)			Relative Change (%) ANT vs. ANP-NNP-BNP			ANP vs. ANT-NNT-BNT			ANT vs. ANP-NNP-BNP	ANP vs. ANT-NNT-BNT	
	PR	TX	TN	PR	TX	TN	PR	TX	TN	PR	TX	TN	PR	TX	TN			
OCT	45.8	22.2	8.7	36.3	23.0	9.3	39.2	22.0	8.0	-21	4	7	-14	-1	8	-14	-4	Anthesis
NOV	39.4	15.4	1.6	28.8	15.9	1.9	35.0	14.7	0.8	-27	3	17	-11	-4	51	31	17	Yield
DEC	18.7	9.4	-4.1	16.3	10.3	-3.6	26.5	9.2	-4.0	-13	9	11	42	-2	2			
JAN	30.6	6.8	-5.7	30.0	7.8	-5.2	40.3	6.6	-5.9	-2	15	10	32	-3	-3			
FEB	46.7	9.1	-3.8	46.9	10.7	-2.8	63.7	9.9	-3.0	1	17	26	36	8	20			
MAR	72.1	13.7	0.5	83.3	14.9	1.3	92.6	14.2	0.8	16	8	164	28	3	-63			
APR	116.6	19.9	6.0	114.8	20.7	6.7	126.2	19.7	5.9	-1	4	12	8	-1	1			
MAY	129.3	24.3	11.5	133.7	24.9	11.8	157.5	24.4	11.7	3	2	2	22	0	-2			
JUN	204.0	27.2	16.9	171.6	27.3	16.9	196.7	27.2	17.2	-16	0	0	-4	0	-2			
JUL	319.9	29.3	21.7	283.1	29.4	21.7	283.8	29.1	21.5	-12	0	0	-11	-1	1			
AUG	304.1	30.5	22.1	287.5	30.3	22.1	281.0	30.5	21.8	-5	-1	0	-8	0	1			
SEP	179.2	26.8	16.6	195.4	27.4	17.5	177.3	27.3	17.0	9	2	5	-1	2	-2			

	NNT vs. ANP-NNP-BNP			NNP vs. ANT-NNT-BNT			NNT vs. ANP-NNP-BNP			NNP vs. ANT-NNT-BNT			NNT vs. ANP-NNP-BNP	NNP vs. ANT-NNT-BNT	
	PR	TX	TN	PR	TX	TN	PR	TX	TN	PR	TX	TN			
OCT	39.9	21.9	8.2	31	22.5	9.0	-13	-1	6	-32	2	-3	-6	-7	Anthesis
NOV	32.6	15.4	1.5	28	16.3	1.9	-17	0	10	-29	6	-20	23	30	Yield
DEC	23.1	10.0	-3.3	17	9.7	-3.5	24	6	19	-9	3	13			
JAN	28.1	6.8	-5.5	20	7.0	-5.4	-8	0	4	-35	4	5			
FEB	39.2	9.2	-4.1	36	9.2	-4.4	-16	0	-7	-24	0	-16			
MAR	77.9	14.1	0.1	66	14.1	0.2	8	2	79	-9	2	61			
APR	105.7	20.3	5.9	104	20.2	5.8	-9	2	1	-11	1	2			
MAY	146.8	24.6	11.3	121	24.6	11.5	14	1	2	-6	1	0			
JUN	182.1	27.4	17.2	173	27.6	17.3	-11	1	-2	-15	2	-2			
JUL	255.6	29.7	21.8	286	30.2	22.2	-20	1	0	-11	3	-2			
AUG	249.8	30.5	21.7	252	30.8	22.3	-18	0	2	-17	1	-1			
SEP	114.3	27.3	16.9	132	27.4	17.4	-36	2	-1	-27	2	-4			

	BNT vs. ANP-NNP-BNP			BNP vs. ANT-NNT-BNT			BNT vs. ANP-NNP-BNP			BNP vs. ANT-NNT-BNT			BNT vs. ANP-NNP-BNP	BNP vs. ANT-NNT-BNT	
	PR	TX	TN	PR	TX	TN	PR	TX	TN	PR	TX	TN			
OCT	44.1	22.2	8.5	49.8	22.6	9.0	-4	0	2	9	2	-4	4	-6	Anthesis
NOV	38.4	15.6	1.6	36.8	15.9	2.2	-2	2	0	-7	4	-39	21	28	Yield
DEC	16.5	8.3	-4.9	12.5	9.7	-4.3	-11	-12	-21	-33	3	-5			
JAN	25.1	6.2	-6.4	23.1	7.2	-5.7	-18	-9	-12	-25	6	0			
FEB	42.5	8.2	-4.6	29.4	9.1	-4.0	-9	-10	-21	-37	0	-6			
MAR	85.3	13.1	-0.1	88.1	13.8	0.3	18	-4	125	22	0	43			
APR	111.8	18.9	4.8	102.1	20.0	5.7	-4	-5	20	-12	0	5			
MAY	120.4	24.4	11.5	122.1	24.9	11.4	-7	0	0	-6	2	1			
JUN	185.6	27.3	17.6	169.3	27.2	17.2	-9	0	-4	-17	0	-2			
JUL	296.0	29.7	22.0	265.2	29.5	21.7	-7	1	-1	-17	1	0			
AUG	242.8	31.1	22.5	247.4	30.6	22.1	-20	2	-2	-19	0	0			
SEP	147.0	27.1	16.4	147.7	27.0	16.4	-18	1	1	-18	1	1			

Table 1. The relative change of seasonal forecast on the 30-year normal climate, and the relative change of the heading time and potential yield of barley of winter seasonal forecast on the heading time and potential yield estimated from observation climate

Initials	Description of nine conditions
BNB	Below Normal Temperature + Below Normal Precipitation
BNN	Below Normal Temperature + Normal Precipitation
BNA	Below Normal Temperature + Above Normal Precipitation
NNB	Normal Temperature + Below Normal Precipitation
NNN	Normal Temperature + Normal Precipitation
NNA	Normal Temperature + Above Normal Precipitation
ANB	Above Normal Temperature + Below Normal Precipitation
ANN	Above Normal Temperature + Normal Precipitation
ANA	Above Normal Temperature + Above Normal Precipitation

Table 2. List of nine scenarios combined by nine conditions of inter-annual variability of winter seasonal forecast during 1988-2013

When predicted seasonal temperature is higher than normal, the heading time was changed by 14% averagely, and the change of predicted potential yield showed 31%.

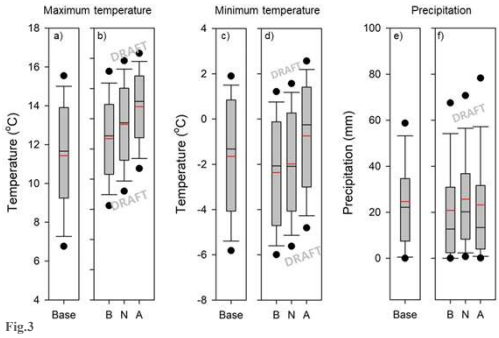

Fig.3

Figure 3 shows the distribution of downscaled winter seasonal daily maximum and minimum temperature and precipitation (during December to January) according to three inter-annual variations of Jinju. Equally in the all panels, 'Base' (a, c, e) represents the 30-year normal in each climate variable. 'B' represents Below Normal, 'N' represents Near Normal, and 'A' is for Above Normal in panels.

In the case of the predicted seasonal precipitation is higher than normal, the change of predicted heading date and potential yield showed 4% and 17%, respectively.

Methods and Materials

Study area & climate period:

- ***Representative growing area of Southern Korea***: Jinju and Miryang (Fig. 4)
- ***Observation climate***: 1988-2013.

Winter seasonal forecast climate:

- *3 inter-annual variability*:
  - *9 combinations (refer: Table 2)*

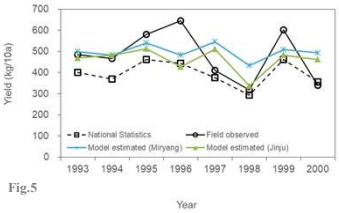

Fig.5

Fig.4

- ***Genetic parameters***: Kim et al. (2012). & refer Fig.5

Crop model simulation:

- ***CERES-Barley (Hoogenboom et al., 2010)***: version 4.6

References:

Hoogenboom, G., J. W. Jones, P. W. Wilkens, C. H. Porter, K. J. Boote, L. A. Hunt, U. Singh, J. L. Lizaso, J. W. White, O. Uryasev, F. S. Royce, R. Ogoshi, A. J. Gijsman, G. Y. Tsuji, and J. Koo, 2010: Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.5 [CDROM], University of Hawaii, USA.

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Conclusion

- It is expected that these seasonal forecast climate data will be available to predict the heading time and potential yield of winter barley in CERES-Barley.
- However, it's expected that there would be some problems in utilizing the seasonal forecast climate information on the potential yield of barley, but this could improve the utilization of seasonal climate prediction information if information on CERES-Barely input parameters (e.g., genetic and soil parameters) are improved more and seasonal forecast climate data suitable for predicting major crop growth periods are applied to the crop model.
- In addition, other than seasonal forecast climatic data produced by multi-site generators used in this study, various statistical methods for downscaling have been developed, for example, simple or multivariate bias correction, or bias correction of spatial parameterization based on correlation between variables or stations and so on.

Future work

We are working on development for assessing rice growth and uncertainty from seasonal forecast climatic data downscaled by SBC on Southeast Asia (e.g., Thailand or Malaysia etc.), it is expected that the downscaled seasonal forecast climate data produced by various downscaled methods developed through these previous studies will be utilized to the agricultural fields.

Acknowledgment:

This study was supported **by APEC Climate Center for Climatic Information Services**. Additionally, thank to Dr. Moosup Kim of our center for providing winter seasonal forecast climate data.