문서번호 APCC-출장-18-1082(2018-11-12)

결재	선임연구원	팀장	부서장	부서장
	11/12 전종안	11/12 이우섭	대결 11/12 윤여훈	대결 11/12 윤여훈
협조	팀장			
	11/12 신용희			

TRAVEL REPORT FORM
출장보고서

I. Travel Overview 출장개요

1. Traveler(s) 출장자

Department 소속	Position 직위(직급)	Name 성명	Note 비고
기후사업본부	선임연구원	전종안, 정유란	

2. Travel Period 출장기간
2018/10/21-25

3. Occasion and destination 행사 및 출장지
FFTC Intrnational Semniar, 타이중 (대만)

II. Major Activities 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

가. 전종안 선임연구원

— 발표 세션 : Session II-Early Warning Systems of Agricultural Disaters through ICT Techniques

— 발표 제목 : Climate-Related Agricultural Risk Management System (CREAMS) for Lowland Rain-fed Rice Productivity in Lao PDR

— 발표 일시 : 10월 22일 (월), 13:30-14:00

— 발표 내용

- APCC에서 2017년부터 2018년 6월까지 1.5년동안 연구개발을 통해 구축한 Climate-RElated Agricultural Risk Management System (CREAMS) 시스템에 대한 개발 과정과 주요 기능을 소개하였음
- CREAMS 시스템의 라오스 현지 기관 (National Agriculture and Forestry Research Institute) 준현업화를 위한 시스템 운영자 교육 및 훈련과 농민과 지역농업관련공무원들의 기후위험관리에대한 인식 제고를 위한 교육 등을 소개하였음

<전종안 선임연구원 발표>

나. 정유란 선임연구원

— 발표 세션 : Session Ⅲ-Vulnerability assessment and economic analysis of agricultural disaster

— 발표 제목 : Capitalizing on Multi-range Forecast Climate Data for Agiculture: A Case Study on Evaluating Crop Reseponses of Crop Model and Its Uncertainty

— 발표 일시 : 10월 23일 (화), 09:00-09:30

— 발표 내용

- APCC 센터에서 생산 및 개발된 계절 예측기후를 농업분야에 활용 가능한 사례를 소개하고 그 예측 불확실성 평가 방법 등에 대해 발표하였음
- 특히, 센터의 상세 기후예측 정보를 계절의 특성 및 작물/타겟 기간에 맞추어 작물모형과 결합하고 작물의 주요 생육단계에 따라 작물 생육 및 생산성의 불확실성 평가 방법에 대해 발표하였음

<정유란 선임연구원 발표>

○ 전종안 선임연구원: Session Ⅲ의 좌장 수행

— 세션 : Session Ⅲ-Vulnerability assessment and economic analysis of agricultural disaster

— 일시: 10월 23일 09:00-10:30

— 다음 과 같은 주제로 총 3인의 발표가 있었음

- Dr. Uran Chung: Capitalizing on Multi-range Forecast Climate Data for Agiculture: A Case Study on Evaluating Crop Reseponses of Crop Model and Its Uncertainty
- Dr. Hsin-Chi Li: Establishment and Application of a Disaster Assessment Platform for Agricultural Loss
- Dr. Hui-Ling Chang, Applying Ensemble Probabilistic Forecasts to Optimize the Decision Making

<전종안 선임연구원 좌장>

○ 전종안 선임연구원: Wrap-up and Discussion Session

— 일시: 10월 23일 15:30-16:10

— 내용: 각 세션 좌장들이 각자의 세션 요약하여 발표하고, Q & A 시간을 가짐.

○ 작물모형에 관한 회의

— 일시: 10월 23일 14:00-15:30

— 참석자: Drs. 전종안, 정유란 (이상 APCC), Drs. Li-Yu Liu and Yu-Chang Tsai (이상, National Taiwan University), Drs. Hui-Ling Chang and Ching-Teng Lee (이상 Central Weather Bureau, CWB), Dr. Chi-Ling Chen (Taiwan Agricultural Research Institute, TARI), Dr. Hen-I Lin, Hui-San Dai, and Naifang Ku (이상 Chung-Hua Institution for Economic Research, CIER)

— 내용: National Taiwan University (NTU)에서 연구개발 중인 작물모형에 대해 소개하고, APCC, NTU, TARI, CIER과 연구협력방안에 대해 논의

<회의 참가자 중 일부>

○ Field sutdy/Educational trip

— 일시: 10월 24일 08:30-18:30

08:30-09:30	GIS center/ Intro of Typhoon 9 major routes to prevent of agricultural disaster
09:30-10:15	From TARI to Jiufengershan
10:15-11:30	Soil and Water Conservation Bureau (Jiufengershan/ Debris Flow Monitoring Station), Council of Agriculture, Executive Yuan
11:30-12:00	Jiufengershan to Restaurant
12:00-13:30	Lunch Break
13:30-14:00	Restaurant to Yumei Farm
14:00-15:30	Yumei Farm
15:30-18:30	From Taichung to TaoYuan City/ Taipei City

<필드스터디 일정표>

<필드스터디 모습>

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

○ Food and Fertilizer Tecnology Center (FFTC) for the Aisan and Pacific Region는 "Strengthening Prevention Stgragegies and Early Warning Systgems for Agicultural Disasters"라는 주제로 국제 세미나를 개최함

○ 전종안 선임연구원과 정유란 선임연구원이 위의 국제세미나에 초청연사로 초청받아 발표, 좌장 등의 역할을 수행함

○ 한국, 대만, 베트남, 말레이시아, 태국의 농업기상재해현황과 각국이 농업기상재해를 줄이기 위한 ICT활용한 기술들을 소개. 농업기상재해감소를 위해 기후서비스의 역할이 필수적이므로 APCC가 이 분야에도 연구역량강화를 위해 노력해야 할 것으로 판단됨

○ CWB와 CIER 등의 대만 정부기관이 APCC와 연구협력과 국제컨퍼런스 공동개최 등의 협력방안에 대한 관심이 매우 큼. 이에 APCC도 아태지역 기후서비스 확대를 위해 현실적 제한을 고려하여 적극적 대응이 요구됨

○ 아시아 국가를 중심으로 최근의 이상기후 및 기후변화에 의한 농업 재해 및 재난의 빈도와 강도가 증가하는 가운데, 극한 기상 영향을 완화하고 효율적인 재해 감소 시스템에 대한 다차원적으로 논의하고 지식 데이터베이스를 구축하기 위해서 기후 자

료를 어떻게 잘 활용해야 할지를 논의할 수 있는 좋은 기회였음

○ 또한, 센터에서 생산된 기후예측 자료를 농업분야에서 활용하고 그 불확실성을 평가한 연구 사례는 대만 농업응용 분야의 연구자들에게 좋은 영향/인상을 준 것으로 판단됨

<세미나일정 및 장소>

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

Strengthening the Prevention Strategies and Early Warning Systems of Agricultural Disasters through Information and Communication Technology (ICT)

Taiwan Agricultural Research Institute (TARI), Council of Agriculture, Taiwan

Oct. 22-24, 2018

Rationale

Agricultural disasters, especially typhoons, heavy rains, and drought, threaten the farmer's income and stable supply of agricultural products. Facing the challenges of future climate change, the frequency and intensity of disasters will be more extreme, and a complete with more efficient disaster reduction system must be constructed to mitigate the impact of extreme weather. As a specific way like the development the disaster prevention technology of important crops production areas, emphasizing the functions of pre-disaster warning, identify the disaster alert area when disaster happen, and post-disaster survey for the rehabilitation of crops. It also clarifies the critical conditions of different crops and growth periods, estimates the probability of occurrence of crop losses, and establishes a complete knowledge database for crop disasters.

In this seminar will emphasize the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. Wise management of crops and the environment using innovative disaster prevention technologies, and setup the early warning systems by ICT techniques to send the disaster messages to farmers, evaluate the vulnerability of cultivation and economic lose by disaster. In other hand, we invite ICT vendors to demonstrate the latest products for environmental monitoring and crop disaster (or cultivation) warning system. The goals of meeting is through the multidimensional discussion will help the development of climate smart agriculture and reduce the impact of natural hazards on food production systems.

TENTATIVE PROGRAM

October 21, 2018 (SUNDAY)

Arrival of Participants

October 22, 2018 (MONDAY)

08:30 - 09:00	Registration
09:00 - 10:00	**Opening Session**
09:00 - 09:30	Welcome Remarks Dr. Junne-Jih Chen, Director General, Taiwan Agricultural Research Institute (TARI) Opening Remarks Dr. Kuo-Ching Lin, Director, Food and Fertilizer Technology Center (FFTC)
09:30 - 09:40	Introduction of the Participants
09:40 - 09:50	Group Photo
09:50 - 10:10	**Coffee Break and Networking**
Session I	**Keynote Lecture** **Moderator : (inviting)**
10:10 - 11:00	Dr. Hiroyuki Ohno, Executive Senior Researcher, Climate Change Adaptation Unit, Division of Climate Change, Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization Research, Japan -An Early Warning and Decision Support System to Reduce Weather and Climate Risks in Agricultural Production (tentative, more general for keynote)

11:10 - 12:00	Dr. Joe-Air Jiang(江昭皚), Professor, Bio-Industrial Mechatronics Engineering, National Taiwan University, Taiwan ICT technique using in environment monitor and pest population prediction.(tentative)
12:00 - 13:30	**Lunch Break**
Session II	**Early Warning Systems of Agricultural Disasters through ICT Techniques** Moderator: inviting
13:30 - 14:00	Dr. Jong Ahn Chun, Research Fellow, APEC Climate Center, Korea Long-range flood/drought risk forecast system (tentative)
14:00 - 14:30	Dr. Tien-Yin Chou (周天穎), Professor, Department of land management, Feng Chia University, Taiwan Using ICT technique to analysis the disaster damage image (tentative)
14:30 - 15:00	Dr. Sayuri Ohkubo, Senior Researcher, Agricultural Meteorology Group, Division of Agro-Environmental Research, Tohoku Agricultural Research Center, Japan The history, improvement and current information service to farmers of the early-warning system against cool-weather damage
15:00 - 15:20	**Coffee/Tea Break**
15:20 - 15:50	Chi-Ming Peng (彭啟明), General Manager, Weather Risk Explore Inc(天氣風險公司)., Taiwan Using ICT technique in agro-meteorological forecast and early warning ,mechanism.
15:50 - 16:20	Ting-Chieh Tu (杜定傑)，Section Manager, Institute for Information Industry(資策會) ., Taiwan Using ICT technique in greenhouse environment monitor and crop

cultivation management .

16:20 - 17:20 ICT Technology show by vendor (Environmental Monitoring Instruments and Systems)

18:00 - 20:00 Welcome Party

October 23, 2018 (TUESDAY)

Session III **Vulnerability assessment and economic analysis of agricultural disaster**

Moderator: inviting

09:00 - 09:30 Dr. Uran Chung, Research Fellow, APEC Climate Center, Korea

Utilization of multi-scale agro-climate information and its uncertainty assessment (tentative)

09:30 - 10:00 Dr. Yuan Shen(申雍) , Profeesor, National Chung-hsing University, Taiwan

Vulnerability assessment of agricultural disasters in Taiwan.

10:00 - 10:20 **Coffee/Tea Break**

10:20 - 10:50 Dr. Hsinchi Lee(李欣輯), Associate Researcher, National Science and Technology Center for Disaster Reduction(NCDR), Taiwan

Agricultural disasters loss assessment platform establishing and application

Session VI **Current Status of Prevention Strategies of Agricultural Disasters**

Moderator : (inviting)

10:50 - 11:20 Korea (candidate)

11:20 - 11:50 Vietnam (candidate)

11:50 - 13:20 Lunch Break

13:20 - 13:50 Malaysia (candidate)

13:50 - 14:20 Philippines (candidate)

14:20 - 14:50 Thailand (candidate)

14:50 - 15:20 Dr. Ming-Hwi Yao, Associate Researcher, Agricultural Engineering Division, Taiwan Agricultural Research Institute –Taiwan (tentative)

15:20 - 15:40 Coffee/Tea Break

15:40 - 16:40 Roundtable Discussion

18:00 - 20:00 Appreciation Dinner

October 24, 2018 (WEDNESDAY)

Session V Field Study Visits

Facilitator:

08:30 - 09:00 Departure from the hotel to TARI

09:00 - 12:00 Taiwan Agricultural Research Institute (TARI)

1. Disaster image analysis -- GIS center
2. Protected agriculture--greenhouse cultivation)

12:00 - 13:30 Lunch Break

13:30 - 14:10 Travel from TARI to Yuch'ih Substation

14:10 - 14:40 Yuch'ih Substation, Tea Research and Extension station

Tea Industry

No.13, Ln. 270, Zhongshan Rd., Yuchi Township, Nantou County

14:40 - 14:55 Travel from Yuch'ih Substation to Sun Moon Lake Weather Station

14:55 - 15:25 Sun moon lake weather station of Central Weather Bureau

Meteorological Observation

No.14, Ln. 270, Zhongshan Rd., Yuchi Township, Nantou County

15:25 - 15:45 Travel from Sun Moon Lake Weather Station to Sun Moon Lake

15:45 - 16:45 Sun Moon Lake

Yuchi Township, Nantou County 555, Taiwan (R.O.C.)

October 25, 2018 (THURSDAY)

Departure of Participants

FOOD AND FERTILIZER TECHNOLOGY CENTER
FOR THE ASIAN AND PACIFIC REGION
5F, 14 Wenchow St., Taipei 106, Taiwan ROC

Tel +886 2 23626239 Fax +886 2 23620478

July 3, 2018
DL180041D

Dr. Jong Ahn Chun
Research Fellow,
APEC Climate Center
12 Centum 7-ro, Haeundae-gu, Busan,48058
Republic of Korea.

Subject: ***FFTC International Seminar of "Strengthening the Prevention Strategies and Early Warning Systems of Agricultural Disasters through Information and Communication Technology (ICT)" to be held on October 22-24, 2018, at Taiwan Agricultural Research Institute in Wufeng Dist., Taichung City, Taiwan***

Dear Dr. Jong Ahn Chun,

Greetings from FFTC!

The Food and Fertilizer Technology Center for the Asian and Pacific Region (FFTC) in collaboration with Taiwan Agricultural Research Institute (TARI) is organizing the above seminar.

On behalf of FFTC and TARI, I would like to invite you as a speaker in this seminar. If you accept this invitation, FFTC will provide you with a round-trip economy class airfare to Taiwan, local transportation, hotel accommodation and a modest per diem and honorarium.

The seminar will focus on the following topics: 1) Introduction of the agricultural disaster warning system in Asia-Pacific region; 2) Agricultural disaster information network based on the use of ICTs; 3) Agricultural disaster-related policy in Asia-Pacific region.

As a speaker, you are expected to deliver a 25-minute oral presentation followed by a ten-minute discussion which meets the seminar theme and to submit a full paper (at least 10 pages of A4 size, single space) to FFTC organizer, Ms. Jennifer Lii (Jennifer@fftc.org.tw) and TARI organizer, Dr. Ming-Hwi Yao (mhyao@tari.gov.tw) before September 14, 2018.

If you accept this invitation, please write back to us with the tentative topic of your paper, personal information sheet, and your CV to FFTC organizer, Ms. Jennifer Lii (jennifer@fftc.org.tw) and TARI organizer, Dr. Ming-Hwi Yao (mhyao@tari.gov.tw) before July 20, 2018. Your cooperation is highly appreciated.

With my best regards,

Kuo Ching Lin

Dr. Kuo-Ching Lin
Director
FFTC

Encl: 1) Workshop Concept Note and Tentative Program 2) The Paper Style Template
3) Guideline to Authors 4) Personal Information Sheet 5) Airfare Announcement

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Kuoching Lin

Dr. Kuo-Ching Lin
Director
FFTC

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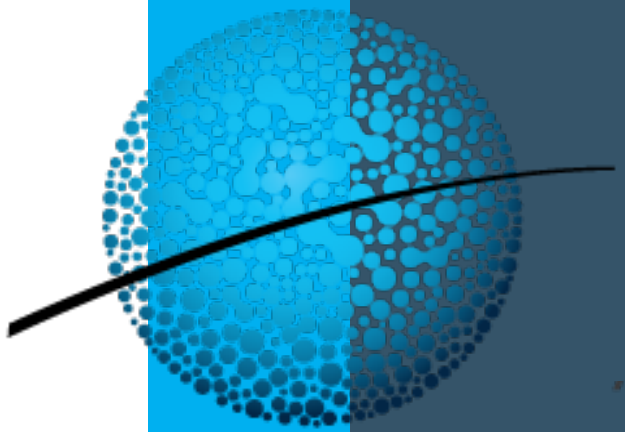
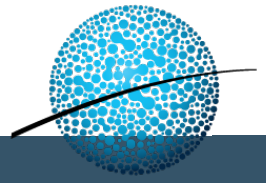
Food Security Enhancement in Southeast Asia



Jong Ahn Chun
APEC Climate Center

Presentation contents



1. Multi-stage research approach
2. CREAMS development
3. Climate Farmer Field Workshop & CREAMS training
4. Multi-scale crop modeling

Ready-Set-Go Framework

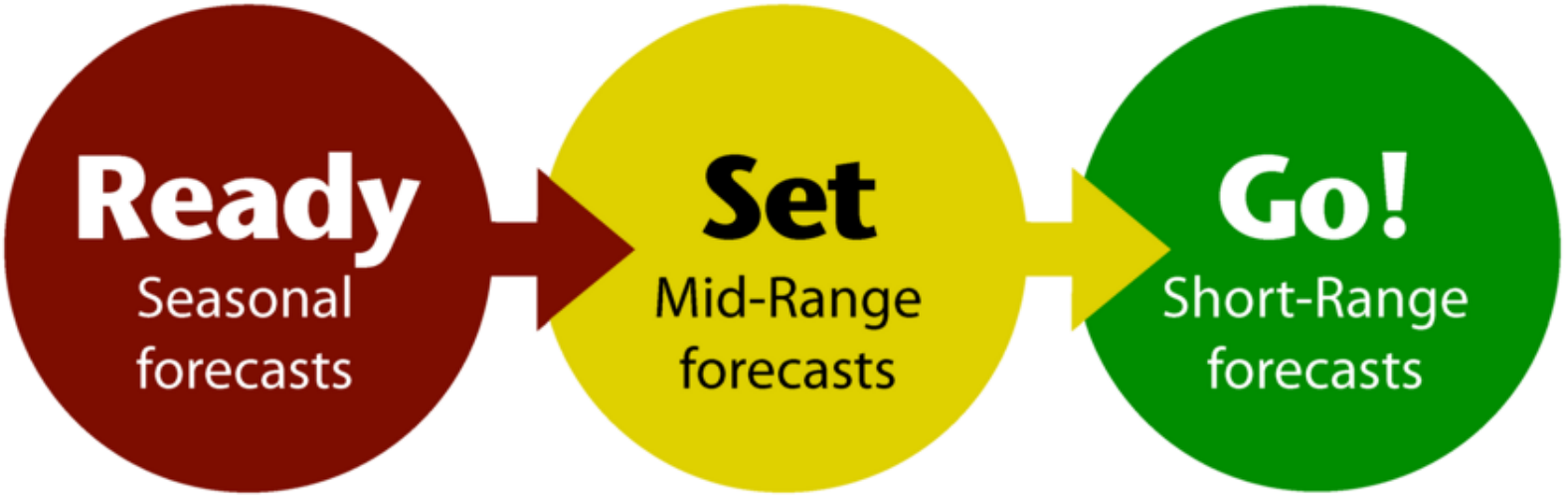
Agriculture Sector

Projected yields

Protect profit; Anticipate market movement

Susceptibility to disease; Optimize irrigation scheduling and pesticide/fertilizer application

Applications of nutrients, pesticides, and herbicides



Humanitarian Aid

Begin monitoring mid-range and short-range forecasts

Update contingency plans

Train volunteers

Sensitize community

Enable early-warning system

Continue monitoring shorter-time-scale forecasts

Mobilize assessment team

Alert volunteers

Warn community

Local preparation activities

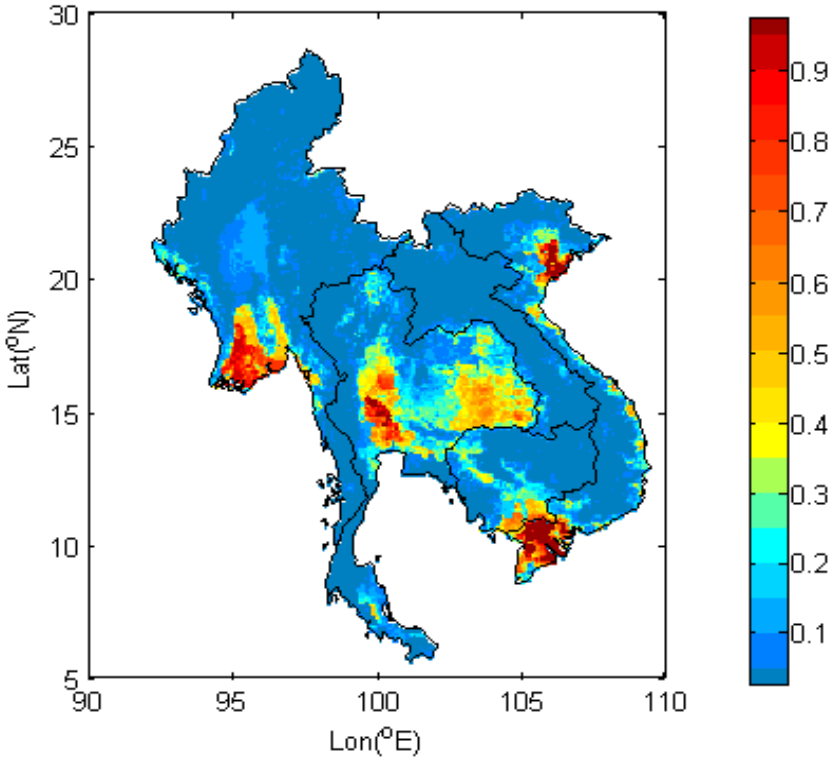
Deploy assessment team

Activate volunteers

Evacuate community

Source: M. Daly

Southeast Asia



The average fractional proportion of a 5-min by 5-min (approximately 10km by 10km) latitude/longitude grid where rice crop was harvested from 1997 to 2003 (Source: Monfreda et al., 2008)

- **Cambodia, Laos, Myanmar, Thailand, and Vietnam**
- **Located between 90–110°E and 5–30°N**
- **Agriculture is one of the most important sectors in these economies**
  - **Accounting for 31% of the GDP in Cambodia, 39% in Laos, 48% in Myanmar, 10% in Thailand, and 20% in Vietnam (WBD, 2005)**
  - **All five economies were listed among the world's 20 greatest rice producing countries in 2013**
  - **Vietnam, Thailand, and Myanmar ranked consecutively as the 5th to 7th (FAO, n.d.)**
  - **Rice is cultivated on over 50% of the agricultural land in each country in the region, except for Myanmar (where rice is cultivated on approximately 45% of agricultural land)**

Climate RElated Agricultural risk Management System (CREAMS) for lowland rain-fed rice productivity in Lao PDR

Project framework

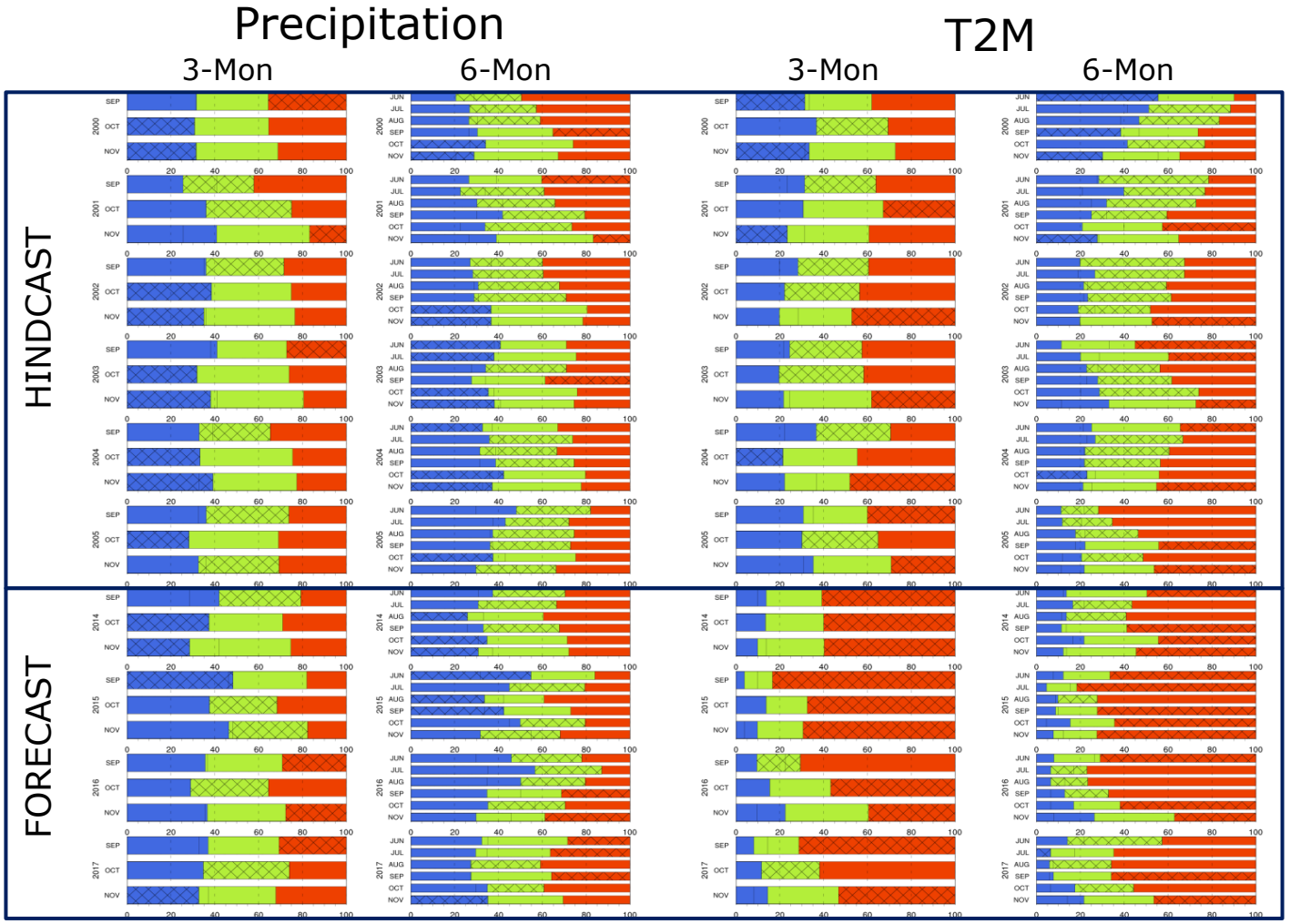
Department of Meteorology and Hydrology

National Agriculture and Forestry Research Institute

Study region in Lao PDR

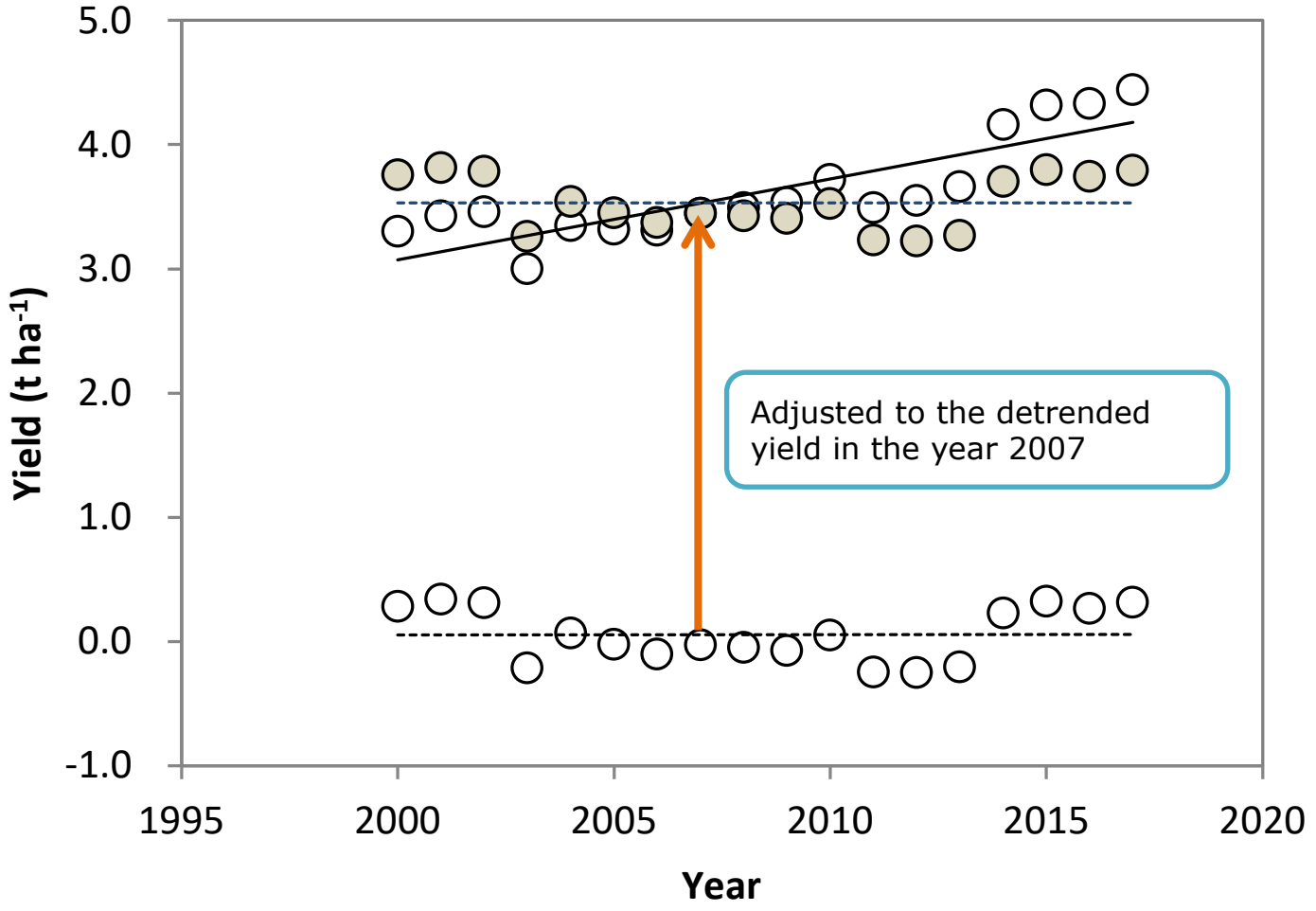
- Lao PDR is a land-locked country
- Area = 236 800 km^2
- 70 % of the country is mountainous
- Border with 5 countries
  - North: China and Myanmar
  - South: Cambodia
  - East: Vietnam
  - West: Thailand ☐
- Administrative divisions: 17 provinces and 1 Vientiane Capital
- Population: 6.7 million, 2014
- Consists of 49 different ethnic group
- Focused on **rain-fed lowland rice farming areas** in **Savannakhet Province**
- The **largest portion** compared to other provinces (23% of total lowland rice areas)

APCC MME Seasonal Forecasts

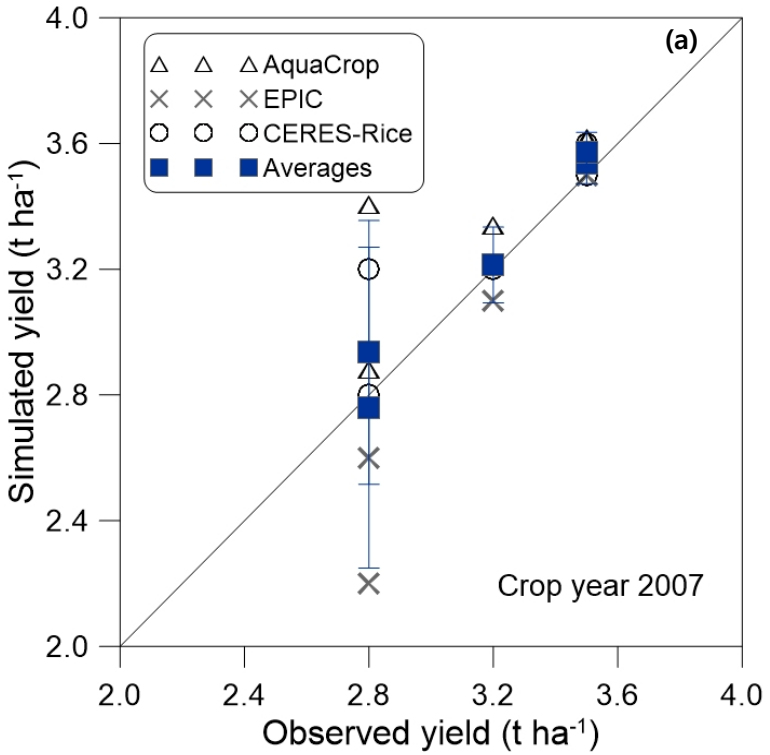


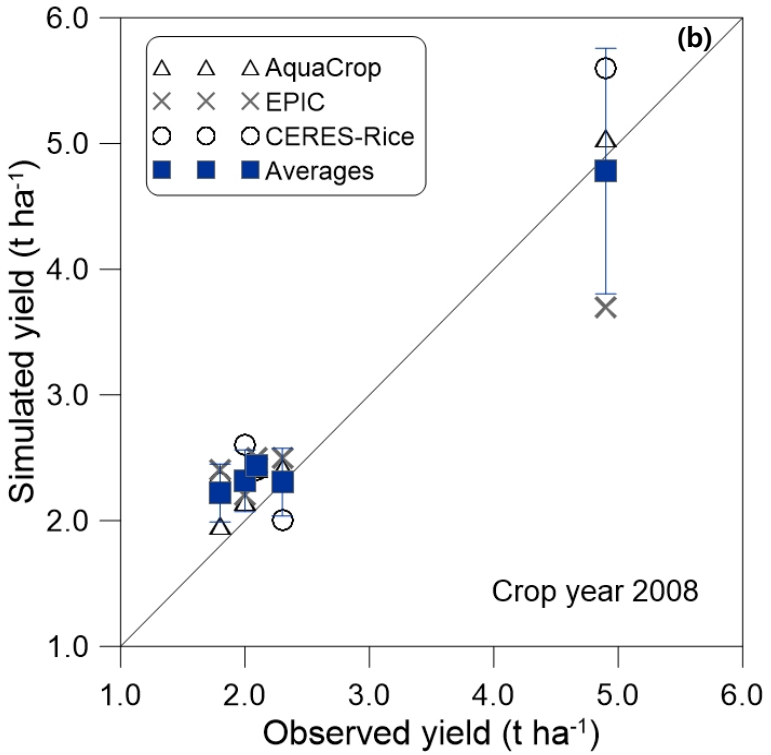
- APCC HINDCAST
  - Period : 1983-2005
- APCC FORECAST
  - Period : 2014~
- Spatial Resolution
  - 2.5° x 2.5°
- Legends
  - RED: Above Normal
  - GREEN: Near Normal
  - BLUE: Below Normal
  - Hatched pattern: Actual observation status
- Station: Savannakhet

Detrended rice yields in Savannakhet

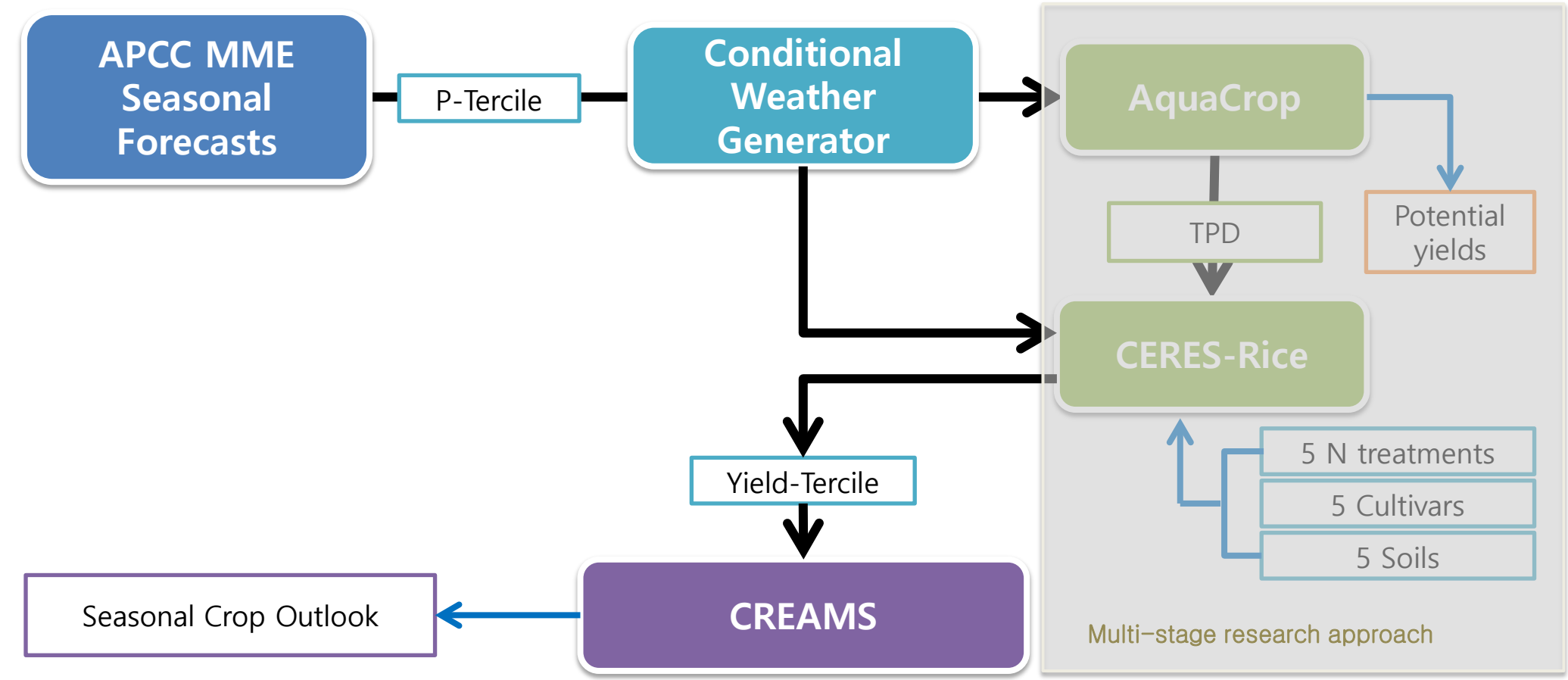


Observed and simulated rice yields in (a) 2007 and (b) 2008



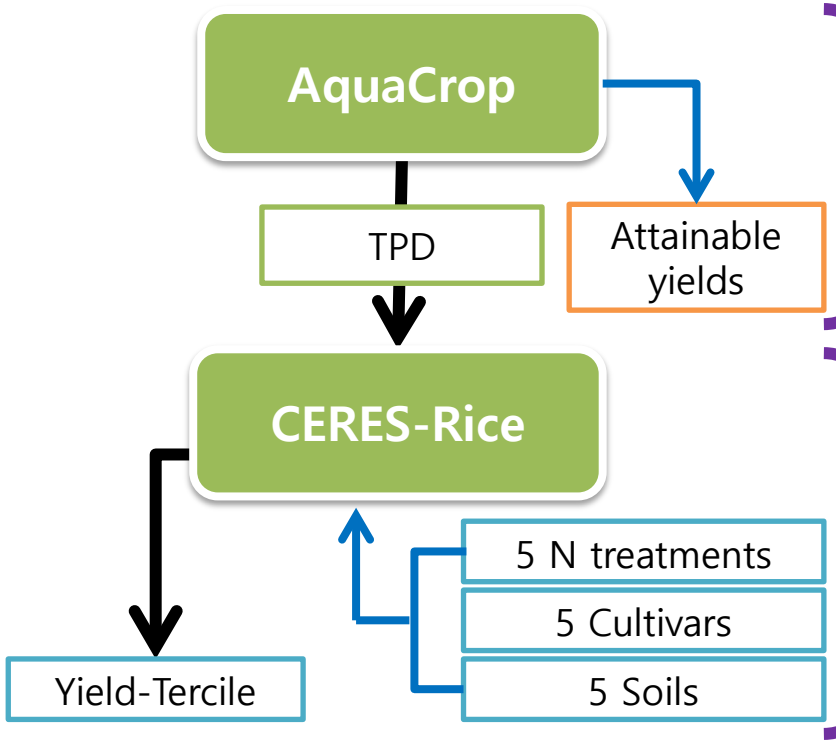


General research strategy



Multi-stage research approach

Based on model's complexity



- Conventional transplanting date: July/1
- Shifting the transplanting date by one day until June/15 and July/15
- 100 simulations for each transplanting date
- Identifying "best" transplanting date
- Estimating attainable yields under the seasonal forecasts

- 25 treatments
  - "Best" transplanting date
  - TDK1, RD10, RD4, Kodeo, TSN2
  - 10, 30, 60, 90, and 150 kg-N/ha (Urea)
  - 100 simulations for a seasonal forecast
- Water/N stress indices at growth stages
- Yield tercile-based categorical probabilities

Observed vs. Simulated

Lead Time (month)	YYYY	Count	Qauntile(2) (%)	Obs	Pred
3	2000	240	48	A	A
		255	52		
	2001	267	54	A	B
		228	46		
	2002	198	40	A	A
		297	60		
	2003	198	40	B	A
		297	60		
	2004	199	40	A	A
		296	60		
	2005	198	40	B	A
		297	60		
	2014	198	40	A	A
		297	60		
	2015	198	40	A	A
		297	60		
	2016	198	40	A	A
		297	60		
	2017	208	42	A	A
		287	58		

Observed vs. Simulated

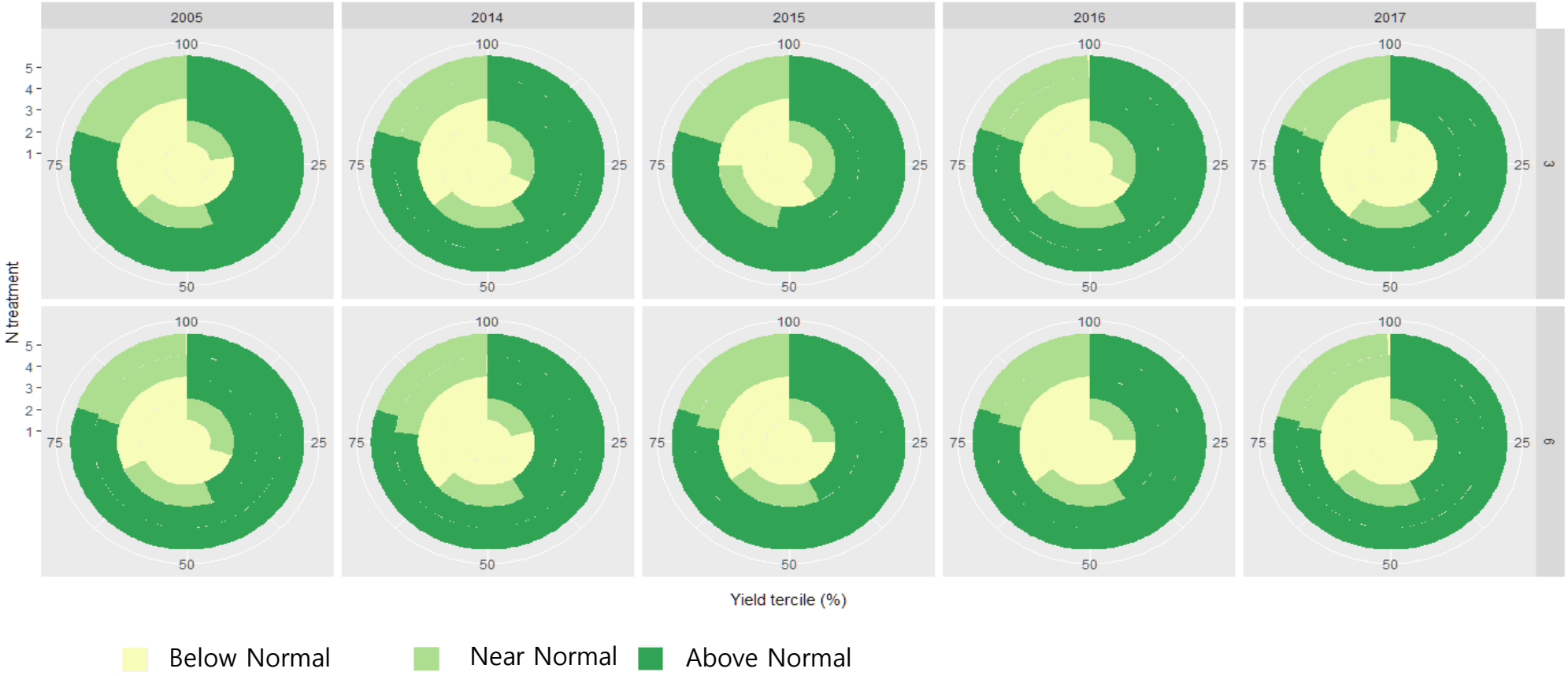
Lead Time (month)	YYYY	Count	Qauntile(2) (%)	Obs	Pred
6	2000	216	44	A	A
		279	56		
	2001	207	42	A	A
		288	58		
	2002	207	42	A	A
		288	58		
	2003	207	42	B	A
		288	58		
	2004	203	41	A	A
		292	59		
	2005	202	41	B	A
		293	59		
	2014	214	43	A	A
		281	57		
	2015	211	43	A	A
		284	57		
	2016	218	44	A	A
		277	56		
	2017	205	41	A	A
		290	59		

Yield estimates from MME

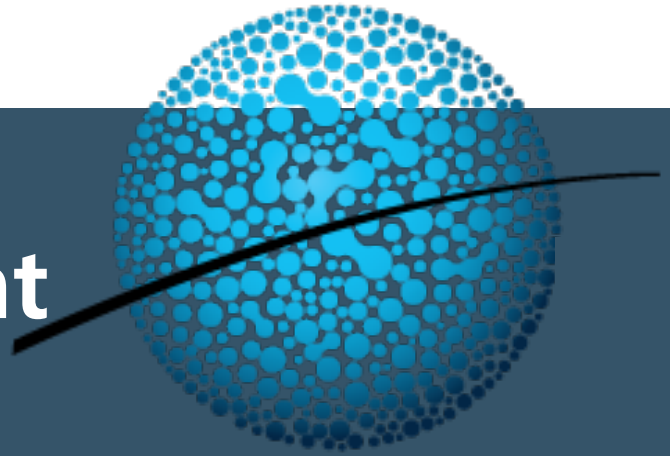
- **Tercile yields**

Yield estimates from MME

- **Tercile yields**

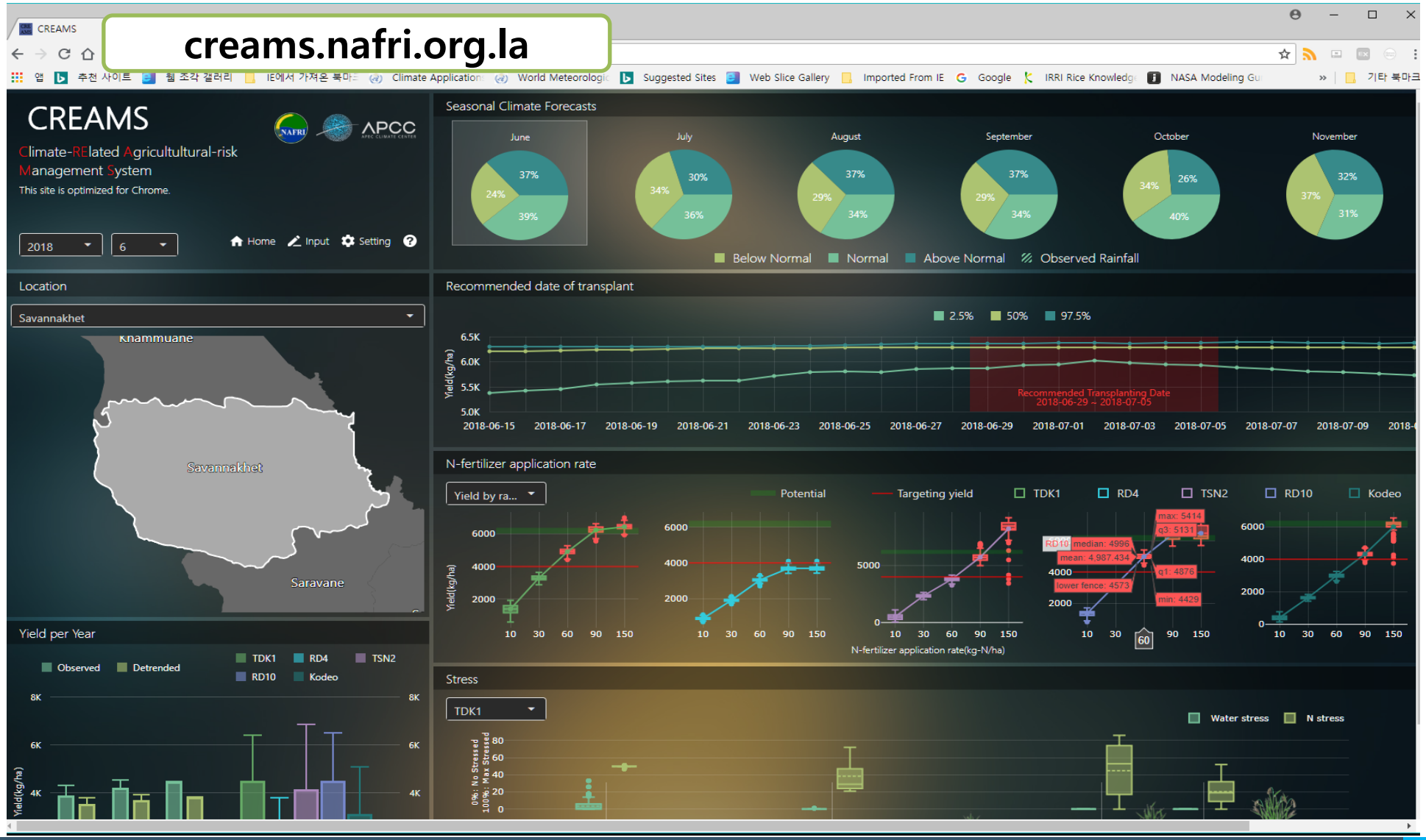


CREAMS development

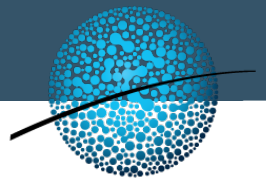


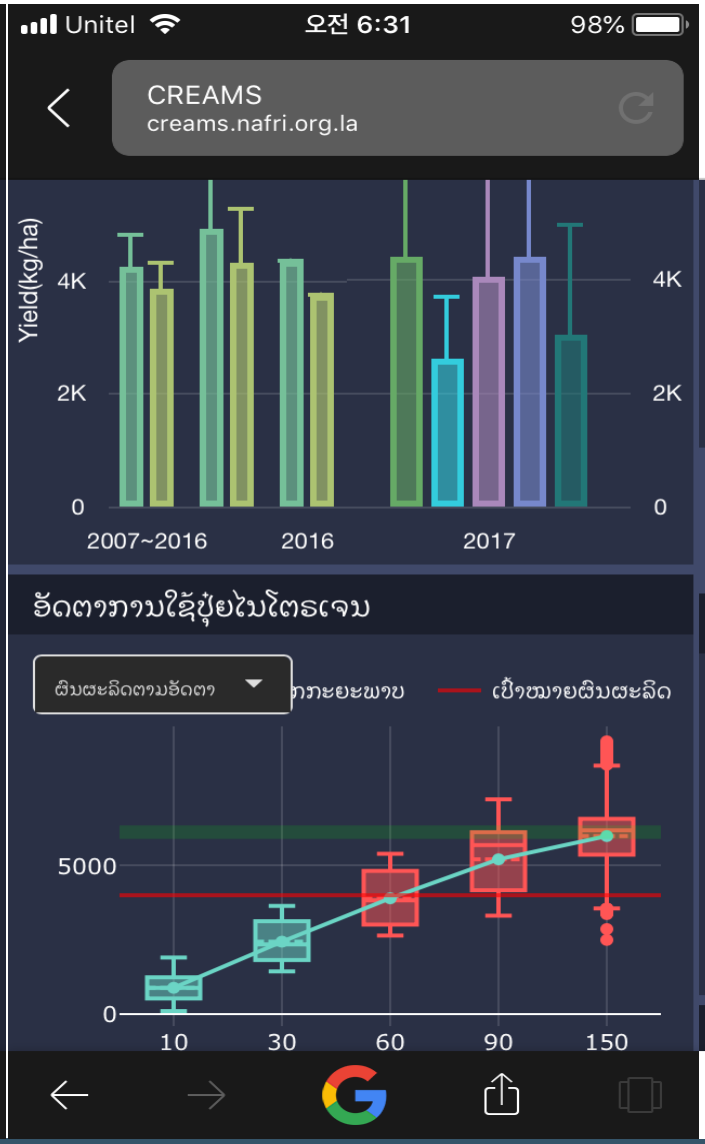
Climate-RElated Agricultural risk Management System

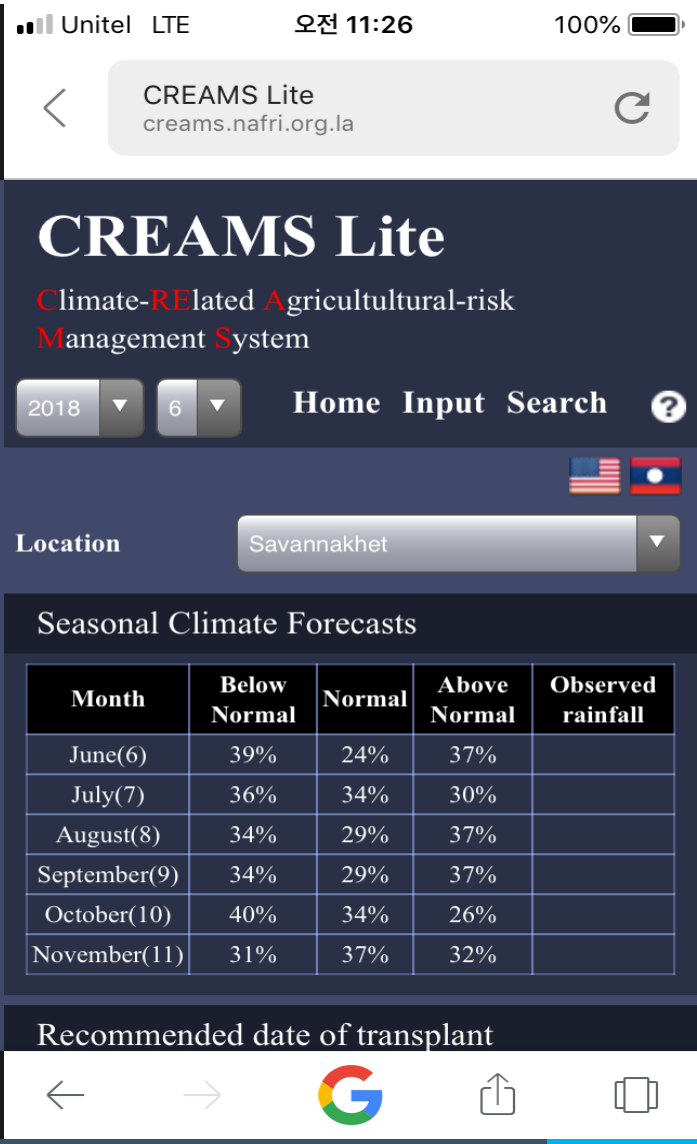
creams.nafri.org.la



CREAMS (mobile version)







CREAMS (mobile version)

Climate Farmer Field Workshop and CREAMS training

Training of trainers and farmers

AquaCrop and CERES-Rice Model Training Seminar

- Date: 2017/12/12
- Location: NAFRI (Vientiane, Laos)
- Participants: About 20
- AquaCrop modeling (Dr. Daeha Kim)
- CERES-Rice modeling (Dr. Jong Ahn Chun)

Final Workshop

- Date: 2018/6/25-27
- Location: NAFRI (Vientiane, Laos)
- Participants: About 20
- AquaCrop modeling (Dr. Daeha Kim)
- CERES-Rice modeling (Dr. Jong Ahn Chun)
- CREAMS: Mr. Jaebum Lee (CUUVA)

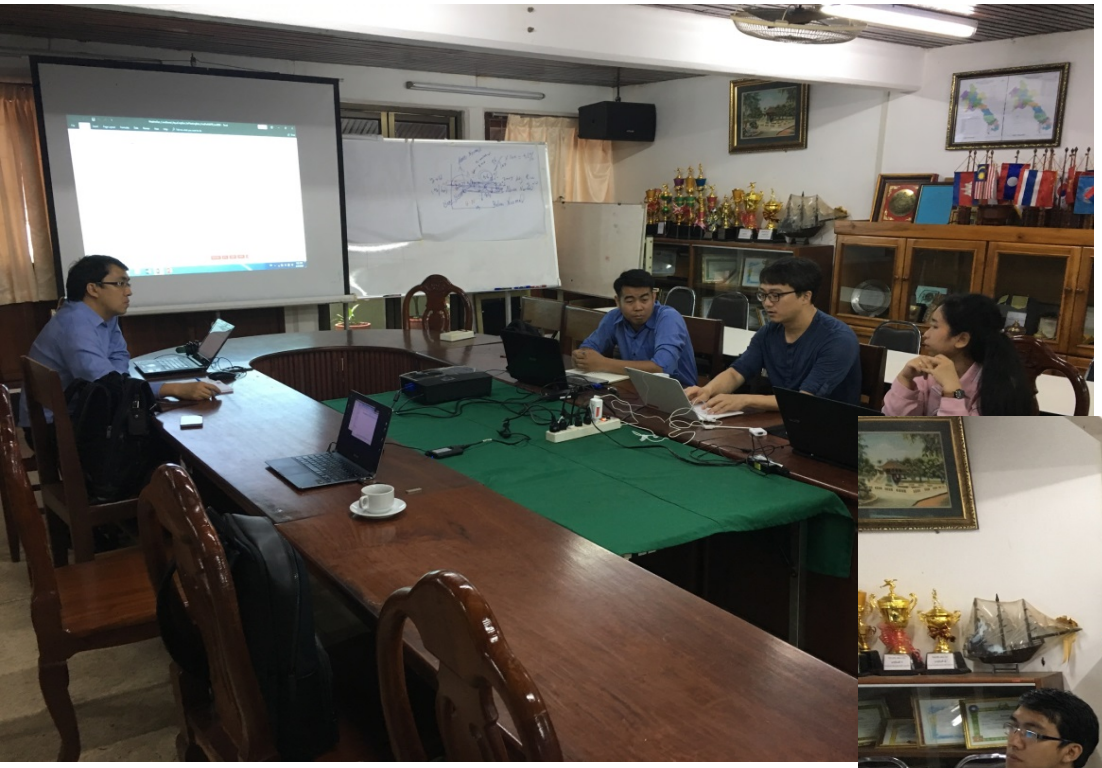
CREAMS server installment

CREAMS Handover Ceremony

CREAMS training

Crop modeling training

CREAMS administrator training

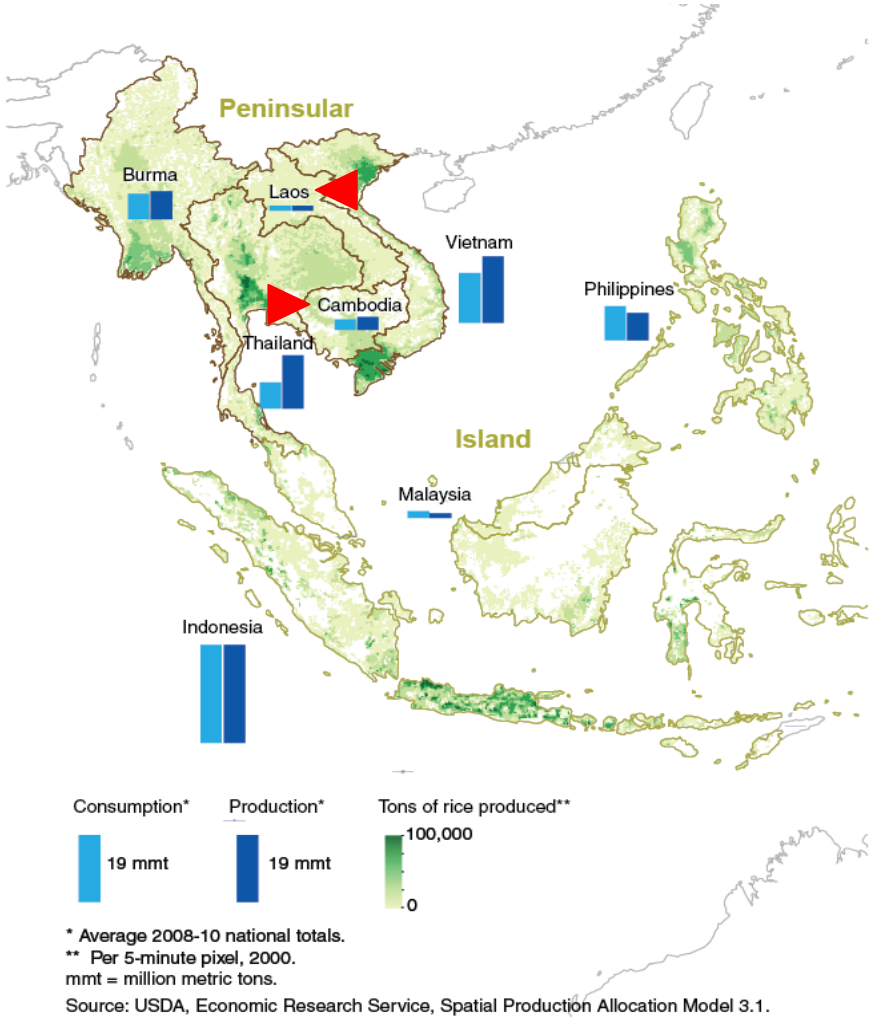


Conclusions

- **Training and educational programs was provided to increase local trainers and farmers' capacity in response to seasonal climate variability.**
- **The semi-operational climate-related agricultural risk management has promise as a tool in reducing seasonal variability of rice yields.**
- **Sustainable operation and management are expected for the CREAMS through the tailoring training workshop to the system administrator.**
- **Further work is recommended on surveying and collecting rice yields and managements in the whole country.**

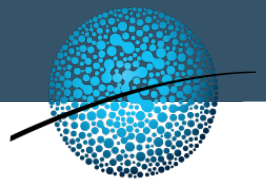
Assessing Rice Productivity and Adaptation Strategies for Southeast Asia under Climate Change through Multi-Scale Crop Modeling

Southeast Asia



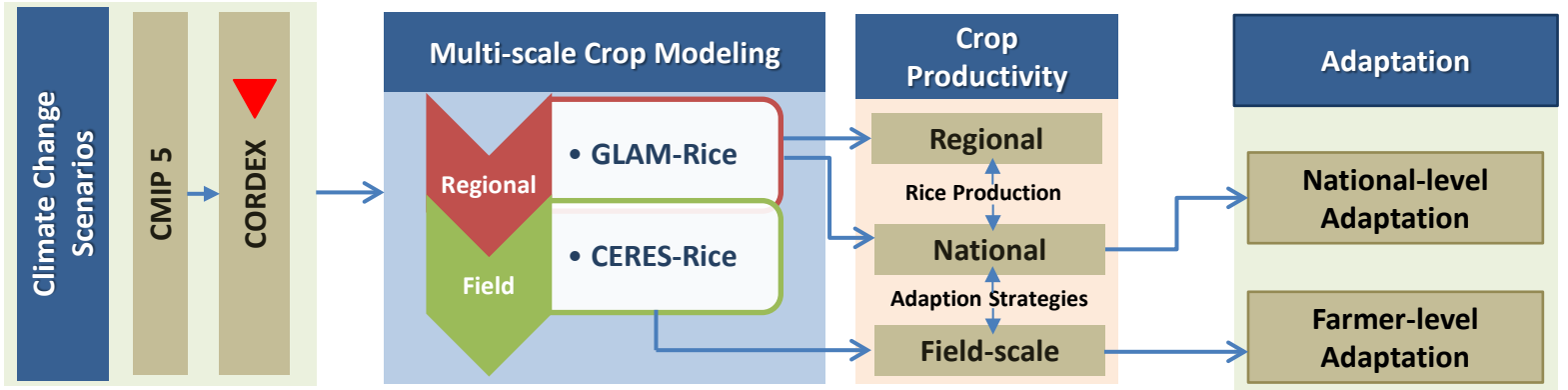
- **Southeast Asia**
  - **One of the regions deemed particularly vulnerable to climate change**
  - **Already being affected by climate change**
- **Rice is one of the most important staple food crop in Southeast Asia**
  - **Approx. 557 million people (IRRI, 2006; Manzanilla et al., 2011)**
  - **The adverse impacts of climate change on rice production systems have been increasing.**
- **The possible impacts of climate change on rice production in Asian countries have been assessed through a number of modeling studies.**

Multi-scale Modeling Approach



- **Global- or regional scale crop models**
  - **M-GAEZ (Global Agro-Ecological Zones) model, GLAM (General Large-Area Model)**
  - **Typically do not provide detailed management information that can be assessed for potential adaptation strategies to reduce the adverse impacts of climate change**
- **Field-scale crop models**
  - **CERES-Rice, ORYZA2000**
  - **Large regions: by aggregating simulation results for each grid cell**
  - **Not all inputs (detailed planting and harvest dates, cultivars, fertilizer management techniques, and soil properties) are available to run the model**
- **Diversity of needs in various stakeholders**
  - **Farmers may be more interested in agricultural management practices at the field level**
  - **Governmental departments are more likely to be interested in national policy or planning**

General Research Strategy: Multi-stage Research Approach



GLAM-Rice

- Identification of a country with the most reduced rice yield
- Assessment of adaptation strategies for the country
- Identification of the most efficacious adaptation strategy
- Further investigation of the spatial distribution of the effects of the adaptation

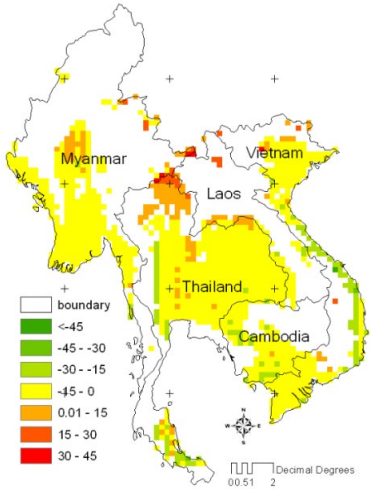
- Best combination of adaptation measures

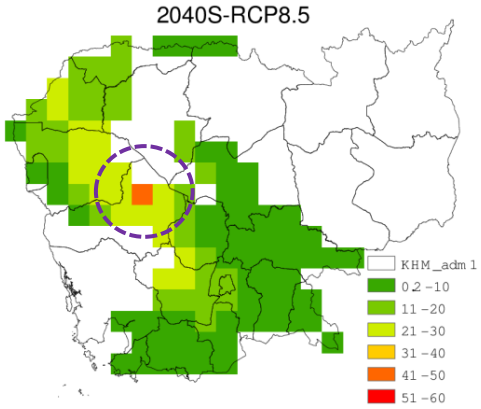
CERES-Rice

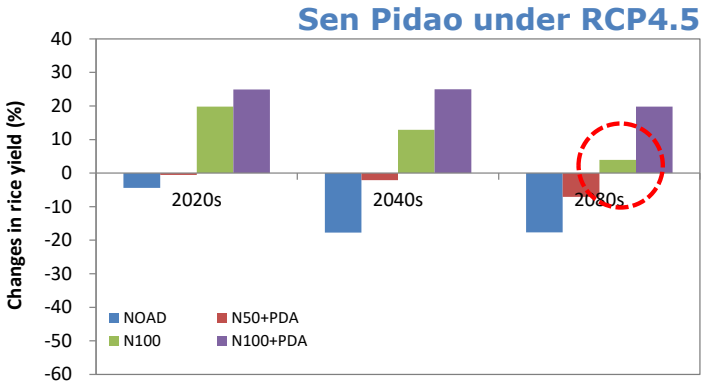
- Most benefited grid cell

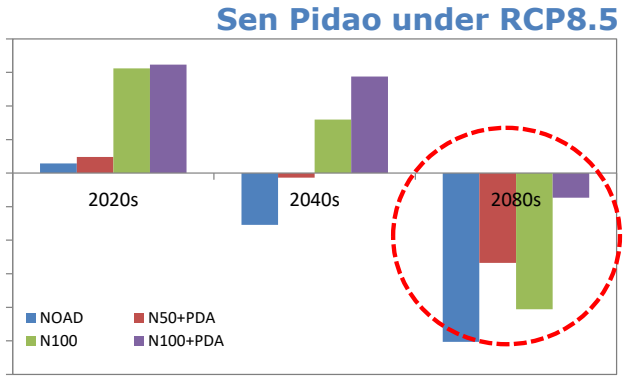
Application of multi-stage research approach

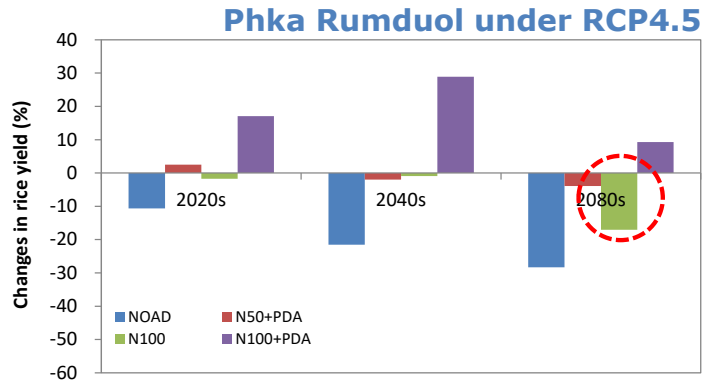
2080s under RCP 8.5

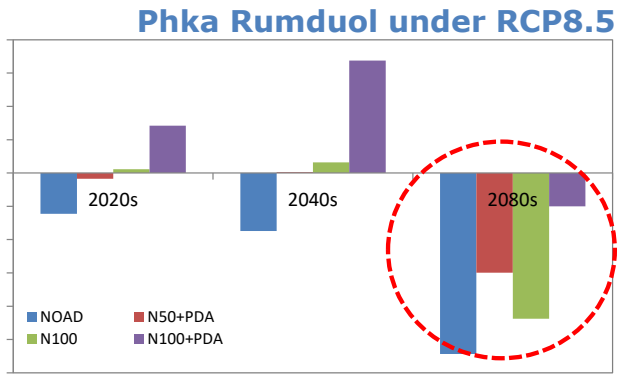












Thank You

APCC
APEC CLIMATE CENTER

Capitalizing of multi-range forecast climate data for agriculture:

a case study of evaluating crop responses of crop model and its uncertainty

Uran Chung

Research Fellow

Integrative Climate Research Team, APEC Climate Center, Busan, Korea

APCC APEC CLIMATE CENTER

October 23, 2018

Agricultural Research Institute, Taichung city, Taiwan

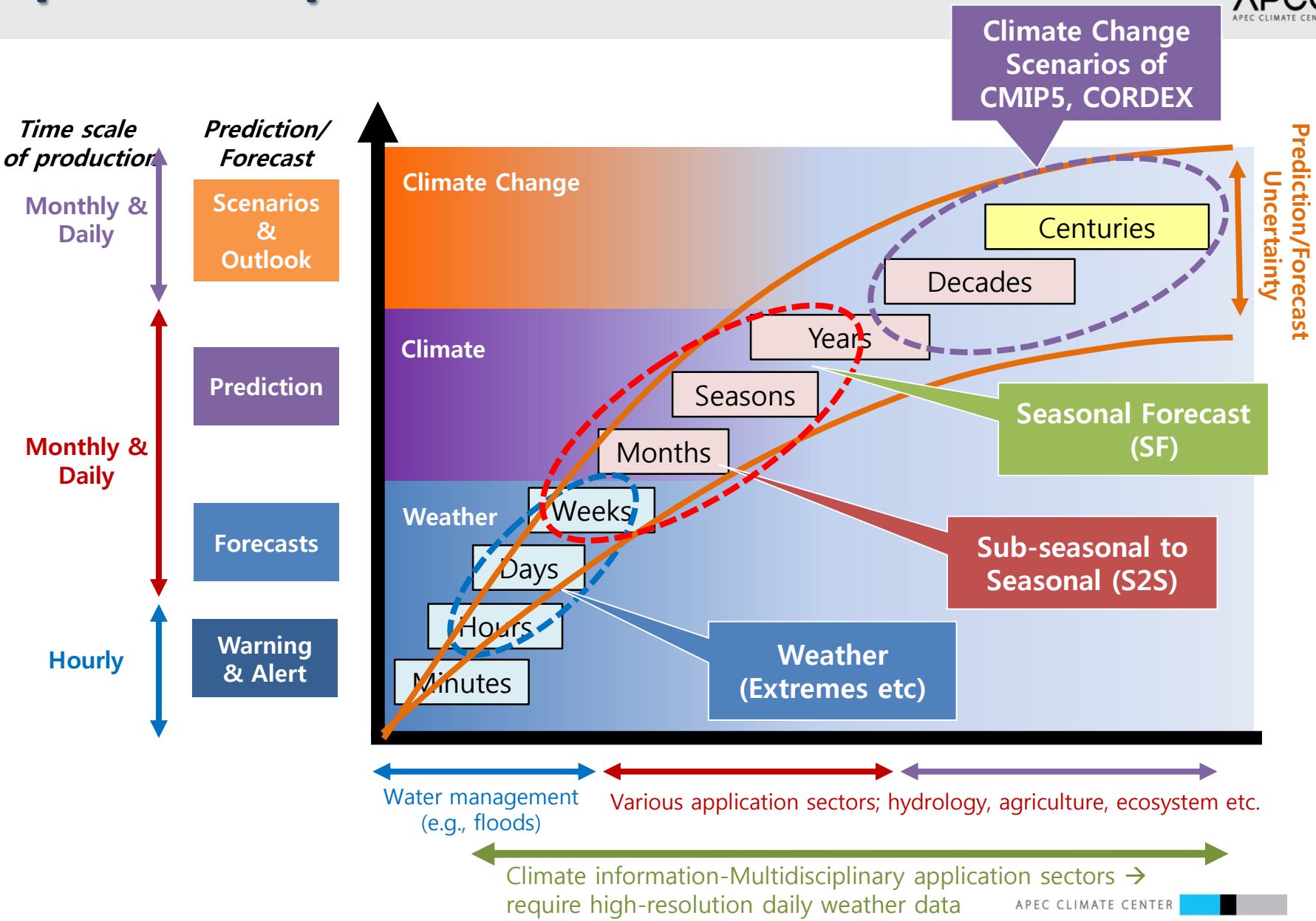
Contents

Backgrounds

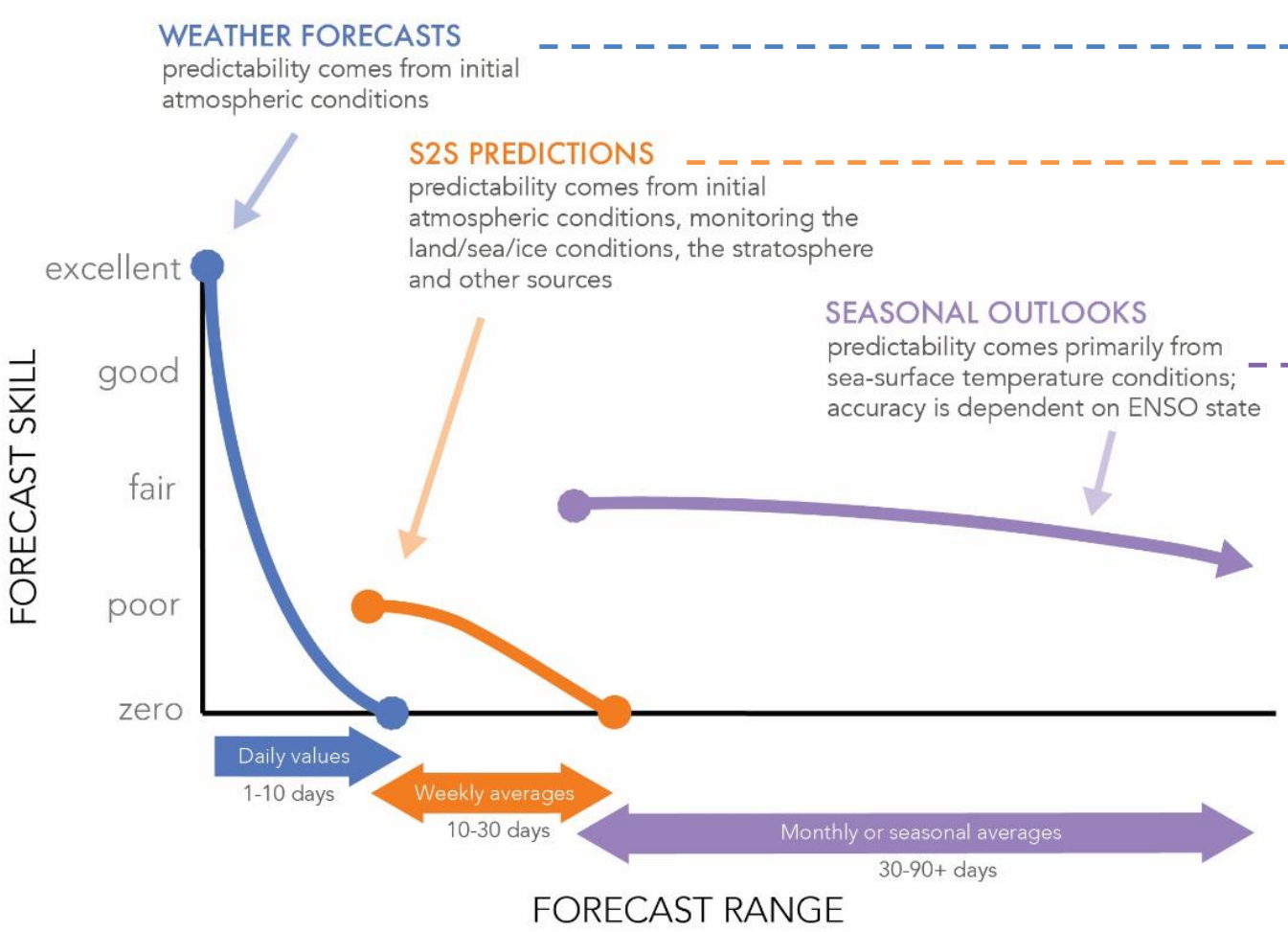
- Development and Improvement of
  - ✓ Seasonal forecast climatic data production skills
  - ✓ Multi-range scale seasonal forecast climate data
  - ✓ Various methods of downscaling these seasonal forecast climate data

- Needs to develop
  - ✓ Application and assessment skills: various fields, such as energy industry, water and ecosystem, agriculture sector and so one…

Spatiotemporal scale of Climate



Blending Climate Data



Observation

Dynamic model
- MME
- S2S
:

Statistic model
- Probability
:

Data Blending Skills

Source: https://iri.columbia.edu/news/qa-subseasonal-prediction-project/

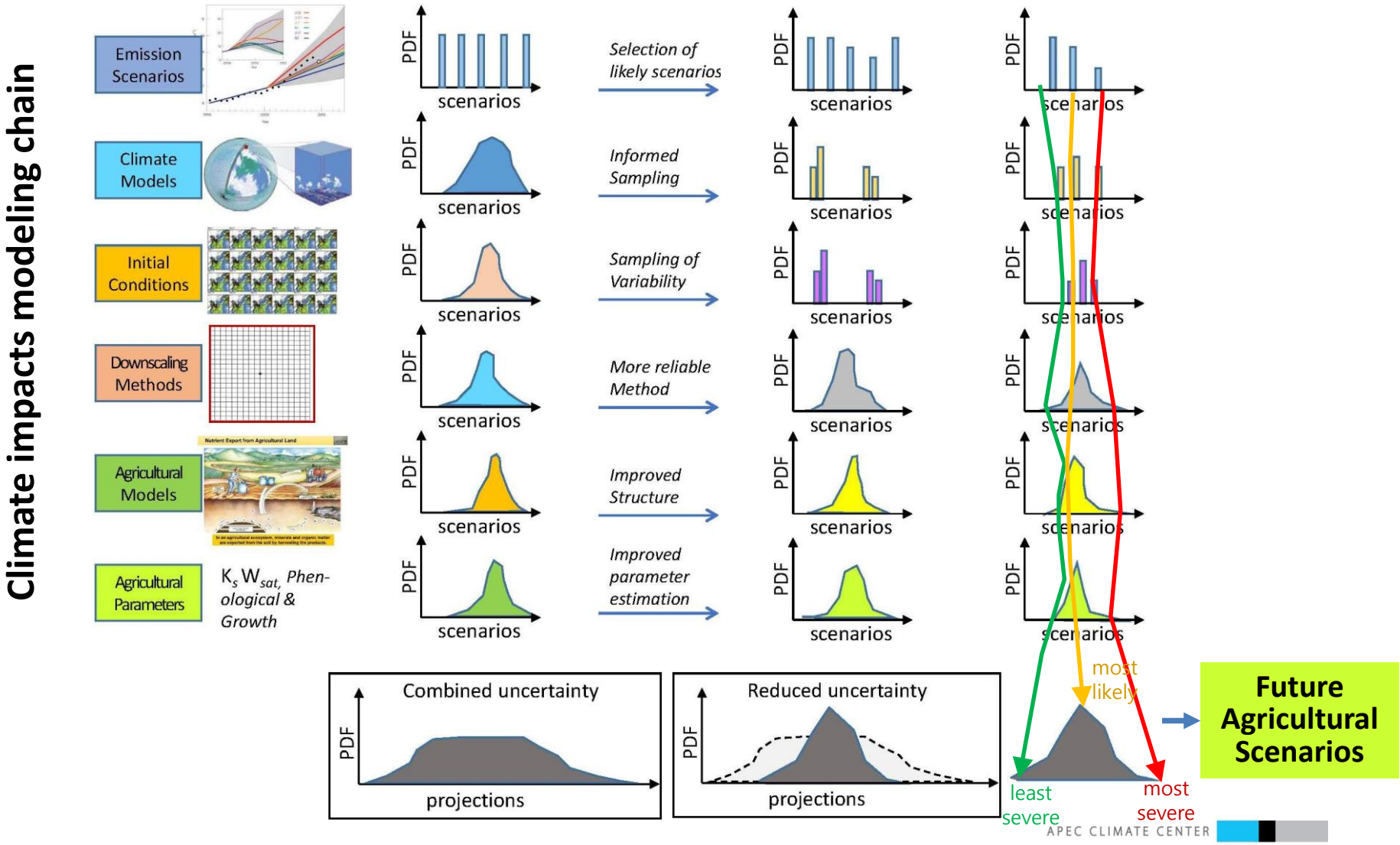
Backgrounds

- Issue of uncertainty
  - ✓ Assessment or evaluation skills
  - ✓ Insufficient references (e.g., criteria for assessment)

- Needs of Developments
  - ✓ Various methods to reduce…
  - ✓ Integrative skills to apply…

Uncertainty factors of Application and its reduction method

Source: Clark et al. (2016)



Backgrounds

- Needs of Developments
  - ✓ Various methods to reduce…
  - ✓ Integrative skills to apply…

Objectives

- Objectives-1; how to utilize
  - ✓ Downscaled forecast climate data in various time scales to predict crop growth responses (e.g., flowering time, yield etc.)
  - ✓ (that is) Development of various application skills

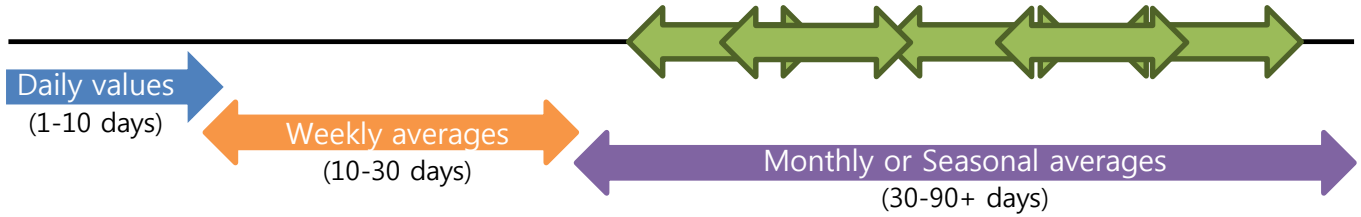
- Objectives-2; exploring of
  - ✓ Whether the prediction of application models are improved or not,
  - ✓ (that is) Development of appropriate assessment methods

Materials and Methods

Multi-range Forecast Climate; Seasonal

Multi-range Seasonal Forecast climate and Target period

- Prediction/Forecast Range vs. Growing Season
  - ✓ Forecast range, lead time…
  - ✓ Target periods…



Forecast Range

Multi-range Seasonal Forecast climate and Target period

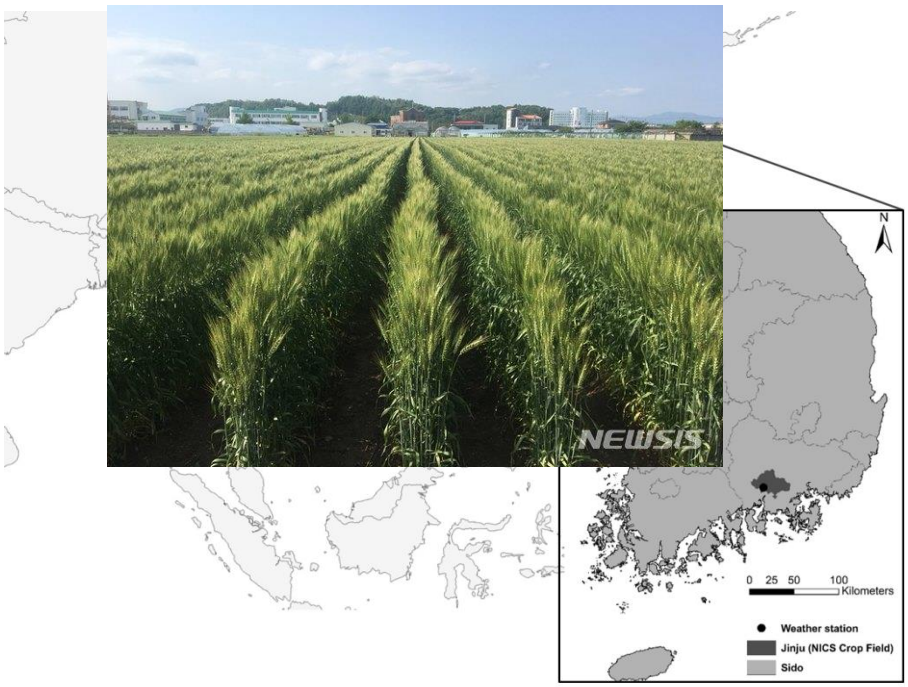
- how to consider the match between multi-time range seasonal forecast climate and crop growing season

✓ Summer Crop: Rice …

>> Northeastern Thailand

✓ Winter Crop: Winter barley …

>> Southern South Korea



Producing/Downscaling Seasonal Forecast climatic data

Winter barley

- Multi-Site Weather Generator
  - ✓ Based on Statistical model
  - ✓ Daily time scale, (*need spatial downscaling, no need temporal DS*)
  - ✓ APCC annual report of Dr. Moosup Kim (2015)

Rice

- APCC MME (Multi-Model Ensembles) Predictions
  - ✓ Collect forecast information from 17 leading climate forecasting centers an institutes in 11 countries (details: http://www.apcc21.org/abt/model.do?lang=en)
  - ✓ Monthly scale, (*need both spatial and temporal DS*)
  - ✓ Spatially and temporally downscaled by SBC (Simple Bias Correction)

Materials and Methods

Data Mixing/Blending Skills;

Combining and Blending Seasonal Forecast Climate data

- Multi-Site Weather Generator
  - ✓ Various seasonal predictive climate scenarios are created with **winter inter-annual variability** depending on the 9 combinations
  - ✓ a year-base

Table. List of winter seasonal forecast climate scenarios predicted during 1988-2013 according to nine conditions

Initials	Description of nine conditions
BNB	Below Normal Temperature (BNT) + Below Normal Precipitation (BNP)
BNN	Below Normal Temperature (BNT) + Normal Precipitation (NNP)
BNA	Below Normal Temperature (BNT) + Above Normal Precipitation (ANP)
NNB	Normal Temperature (NNT) + Below Normal Precipitation (BNP)
NNN	Normal Temperature (NNT) + Normal Precipitation (NNP)
NNA	Normal Temperature (NNT) + Above Normal Precipitation (ANP)
ANB	Above Normal Temperature (ANT) + Below Normal Precipitation (BNP)
ANN	Above Normal Temperature (ANT) + Normal Precipitation (NNP)
ANA	Above Normal Temperature (ANT) + Above Normal Precipitation (ANP)

Combining and Blending Seasonal Forecast Climate data

- APCC MME Predictions
  - ✓ These predicted climatic data are generated for up to 6 months
  - ✓ Month-base
  - ✓ Needs applying a method for evaluating monthly predictability

Appling to predict crop growth response

- CERES-Barley and CERES-Rice
- Genetic parameters
  - ✓ Kim et al. (2012)
  - ✓ Babel et al. (2011)
- Soil Information
  - ✓ Digital Soil Map,
  - ✓ FAO WISE database
- Crop Managements
  - ✓ Planting date,
  - ✓ fertilizer, irrigation, and so on (antibiotic stress …)

Analysis & Assessment of Uncertainty?

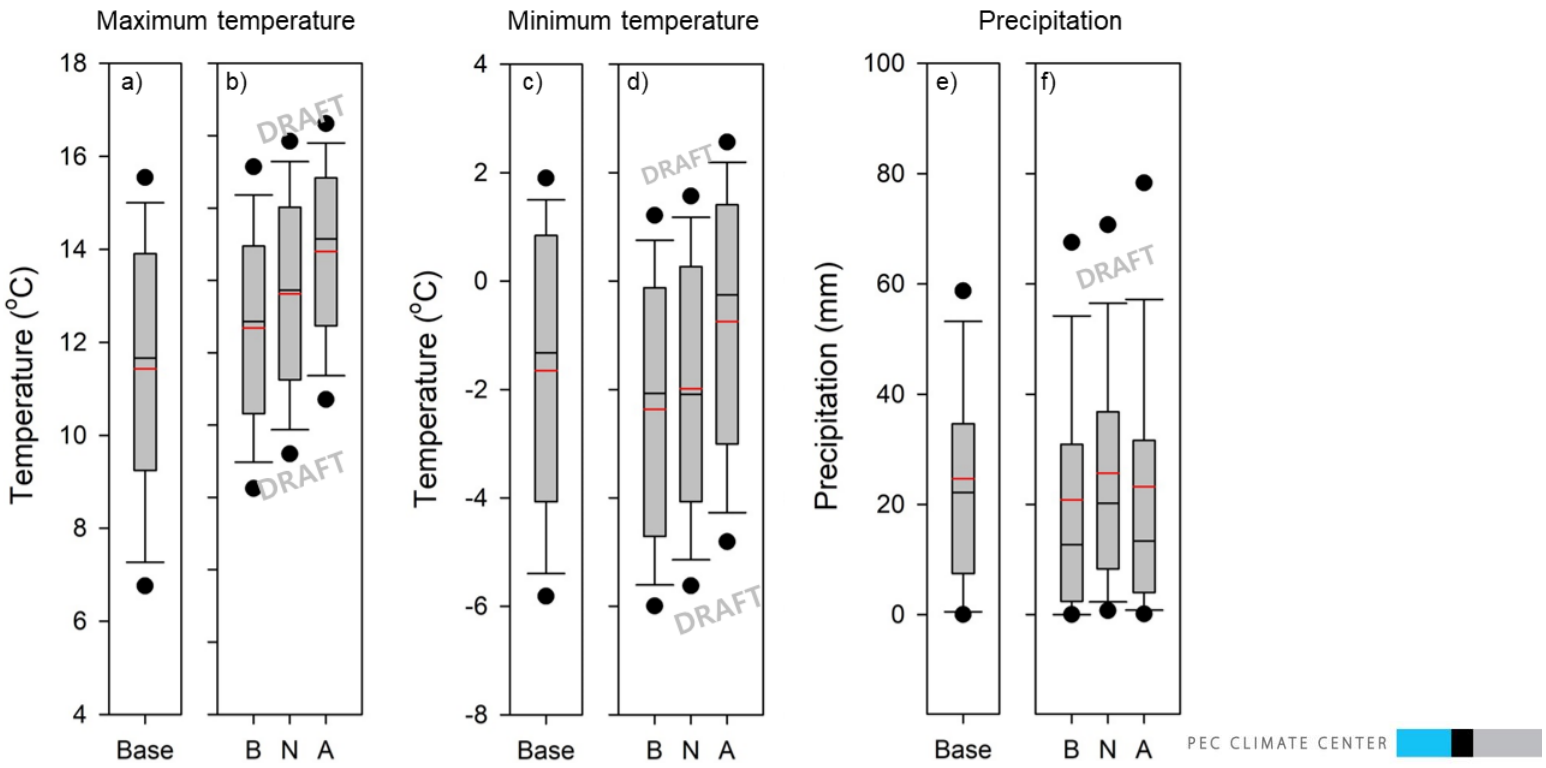
- How to assess & what evaluate
  - ✓ The predicted results after crop model simulation
  - ✓ Predictability improvement: Has forecast climate utilization improved crop model predictions?
  - ✓ Uncertainties: crop model itself, …
- Assessment
  - ✓ Difference, error, standard deviation
  - ✓ Correlation,

Preliminary Results;

Winter Seasonal Forecast Climate & Winter Barley

Characters of the Downscaled Winter Seasonal Forecast Climate

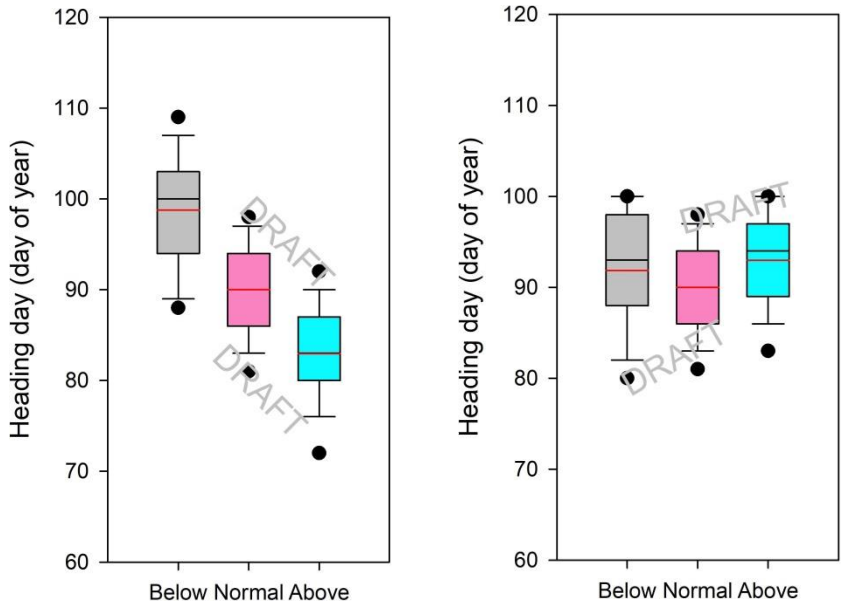
- Reproducibility
  - ✓ according to winter inter-annual variability combination

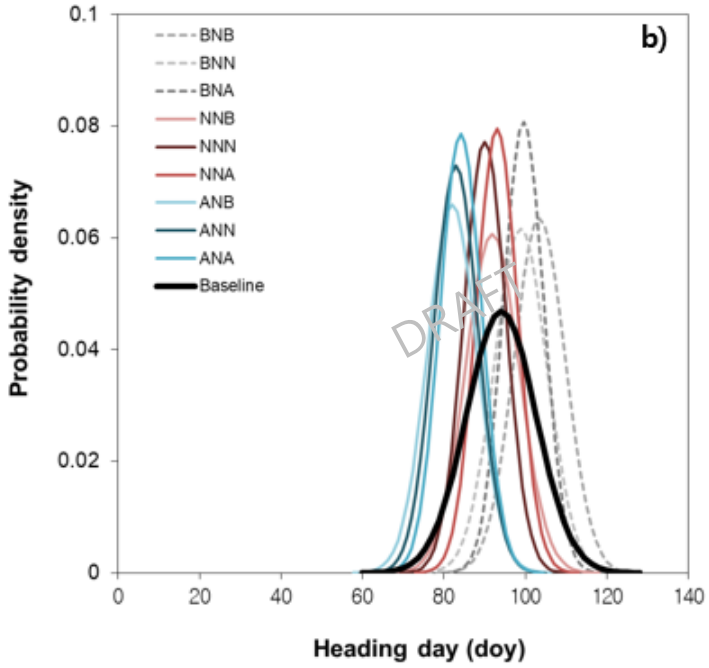


Evaluation of the Predicted Barley Growth Response based on Winter Seasonal Forecast Climate

- Predictability
  - ✓ according to winter inter-annual variability combination
  - ✓ Heading day (*correl: 0.73*)

Standard Deviation (day)	B	N	A	OBS	B	N	A
	6.3	5.6	5.0	3.2	5.9	5.67	5.5

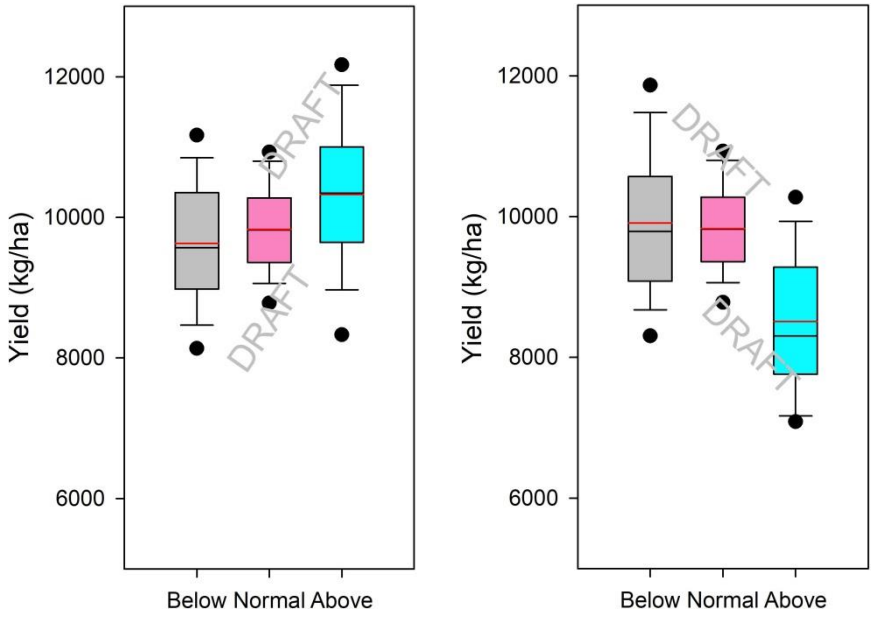


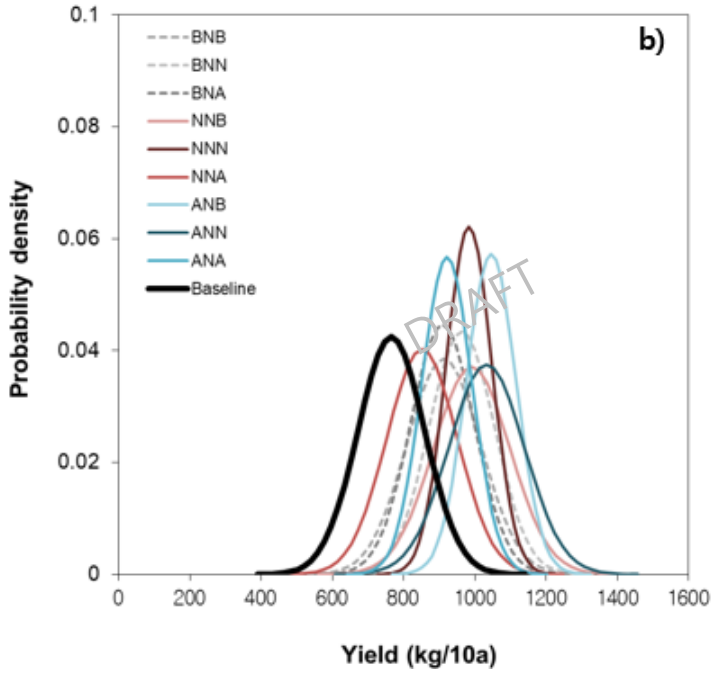


Evaluation of the Predicted Barley Growth Response based on Winter Seasonal Forecast Climate

- Predictability
  - ✓ according to winter inter-annual variability combination
  - ✓ Potential yield of winter barley (*correl: 0.47*)

		B	N	A	OBS	B	N	A
Standard Deviation	(kg/10a)	93.7	87.5	86.3	69.4	95.0	90.4	82.1



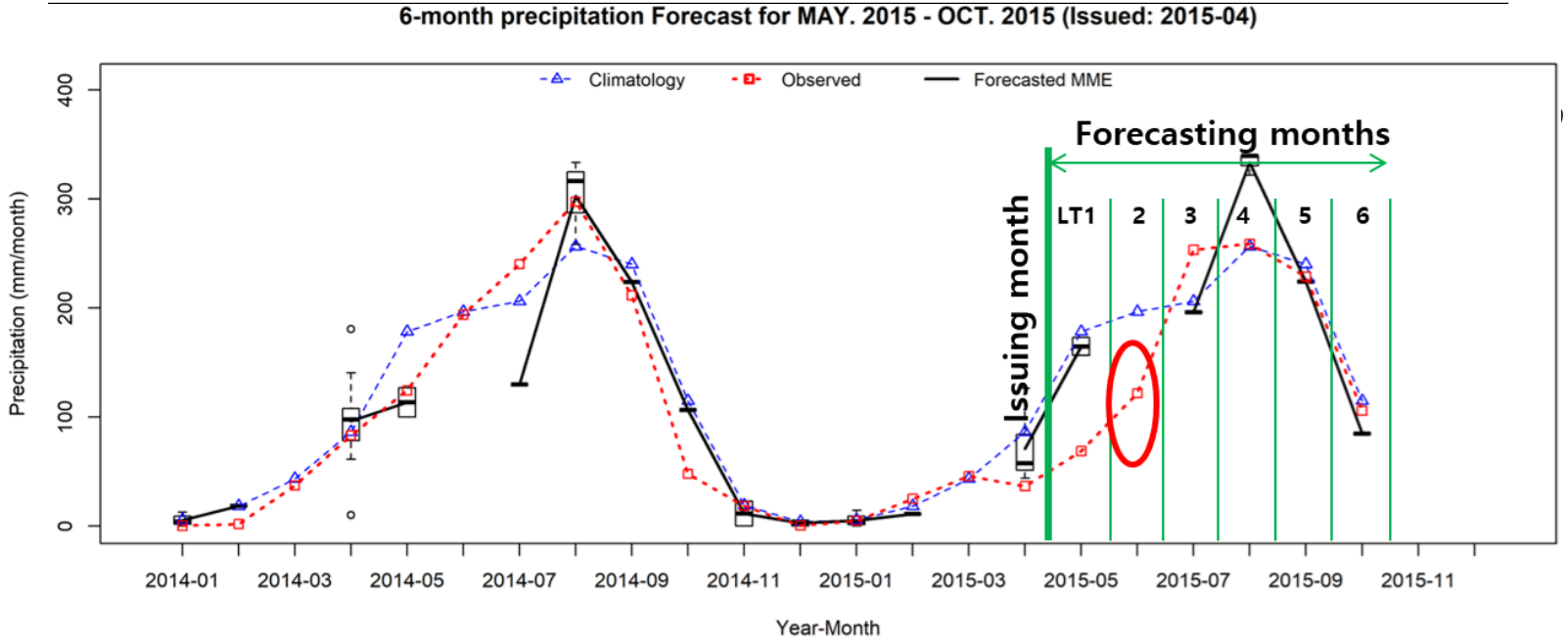


Preliminary Results;

APCC Seasonal forecast climate & Rice

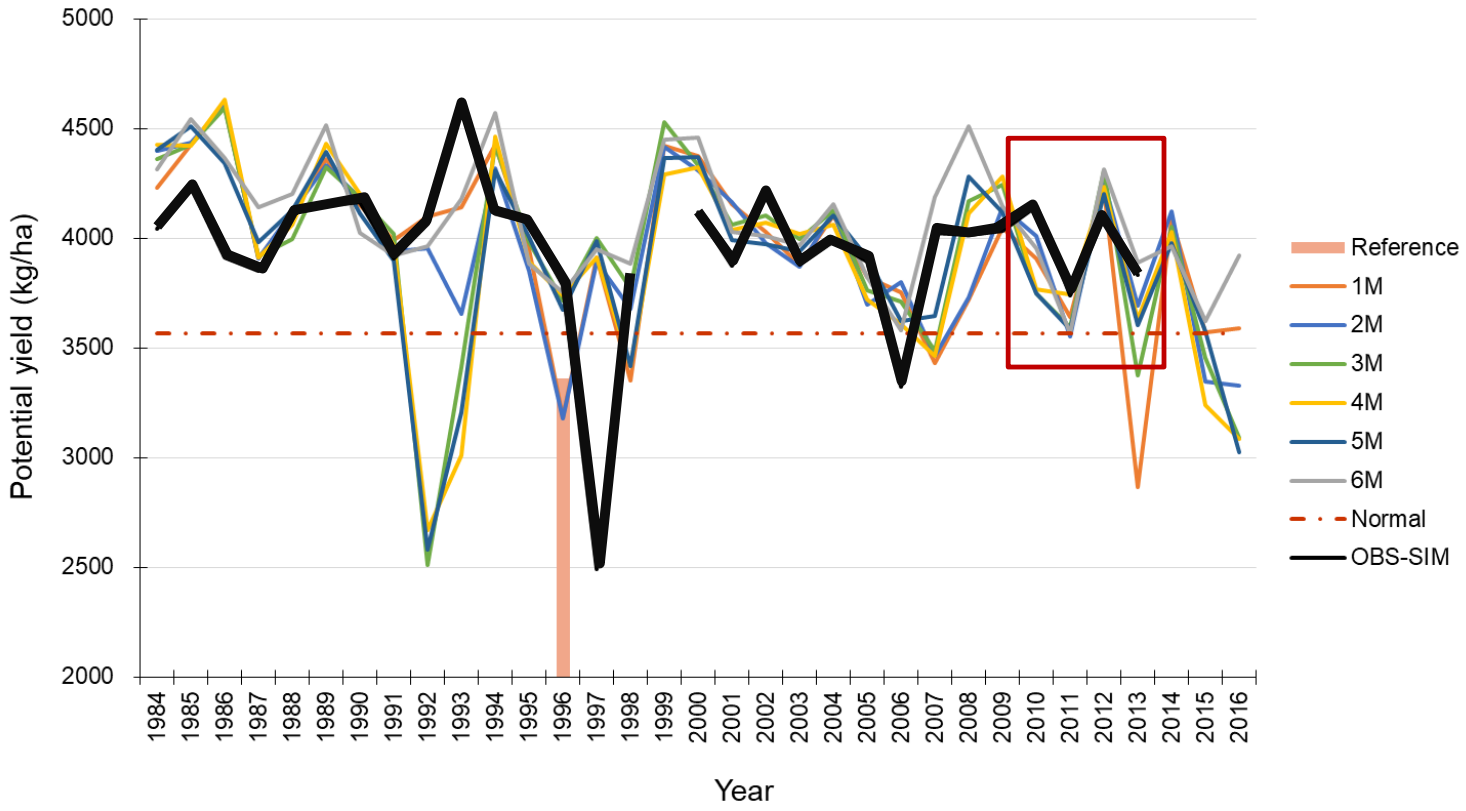
Characters of the Downscaled Forecast Climate during Rainy Season

- Predictability
  - ✓ Monthly TCC
  - ✓ the inter-annual variability



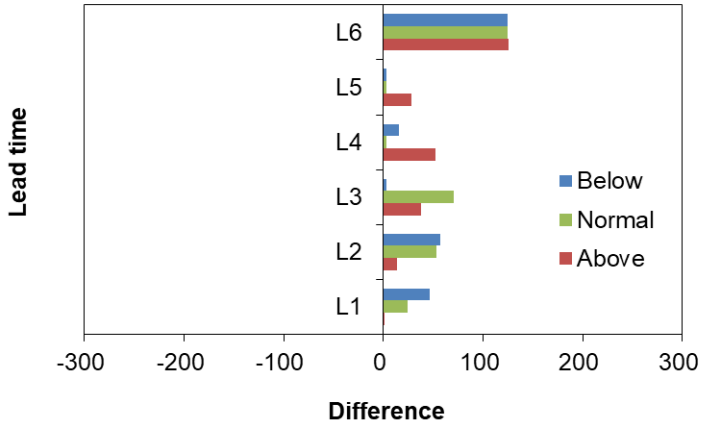
Evaluation of the Predicted Rice Growth Response based on Seasonal Forecast Climate

- Reproducibility
  - ✓ Yield
  - ✓ by Lead time



Evaluation of the Predicted Rice Growth Response based on Seasonal Forecast Climate

- Predictability
  - ✓ Monthly predictability of potential yield
  - ✓ each lead time, **the shorter lead time, the smaller error**
  - ✓ planting month as lead time,
    the shorter lead time, the higher correlation



Conclusions;

from preliminary results

Conclusions

- OBS-1:
  - ✓ Target period vs. Growing season
  - ✓ Be able to Mix or Blend

- OBS-2:
  - ✓ Not Certainly Determination of improvement
  - ✓ but, the Shorter Lead time, the Closer to True value

    (that is, the more improved when the lead time is getting short.)

Utility of a Three-Tier Forecast System

By Peter J. Webster

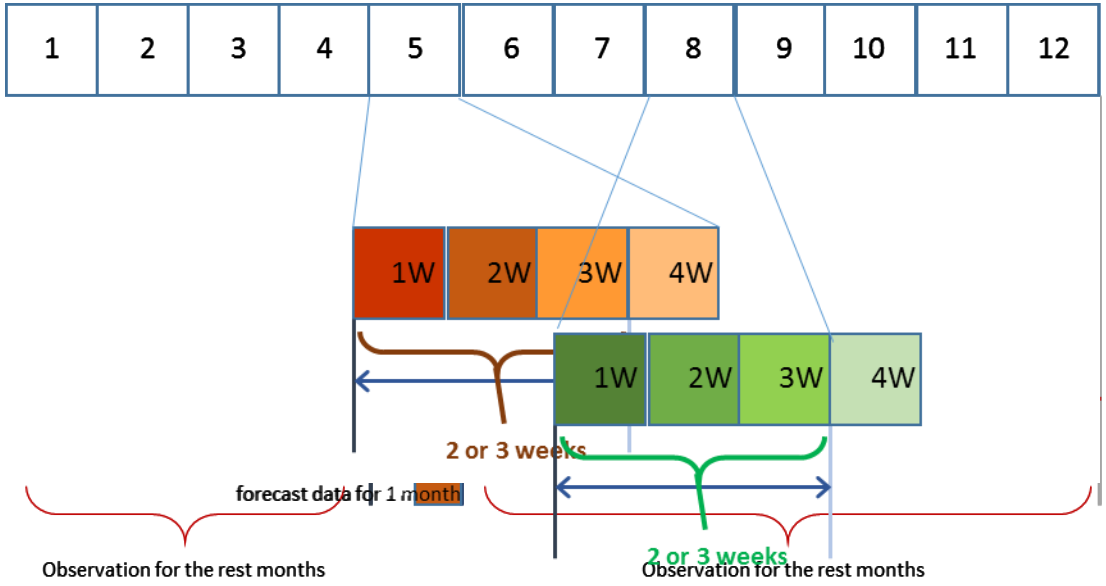
SEASONAL OUTLOOK: Long term planning of agriculture, water resource management & disaster mitigation especially if high probability of anomalous season (e.g., flood/drought).

20-25 DAY FORECAST: Broad-scale planning schedules for planting, harvesting, pesticide & fertilizer application and water resource management (e.g., irrigation/hydro-power determination). Major disaster mitigation resource allocation.

1-10 DAY FORECAST: Detailed agriculture, water resource and disaster planning (e.g., fine tuning of reservoir level, planting and harvesting).

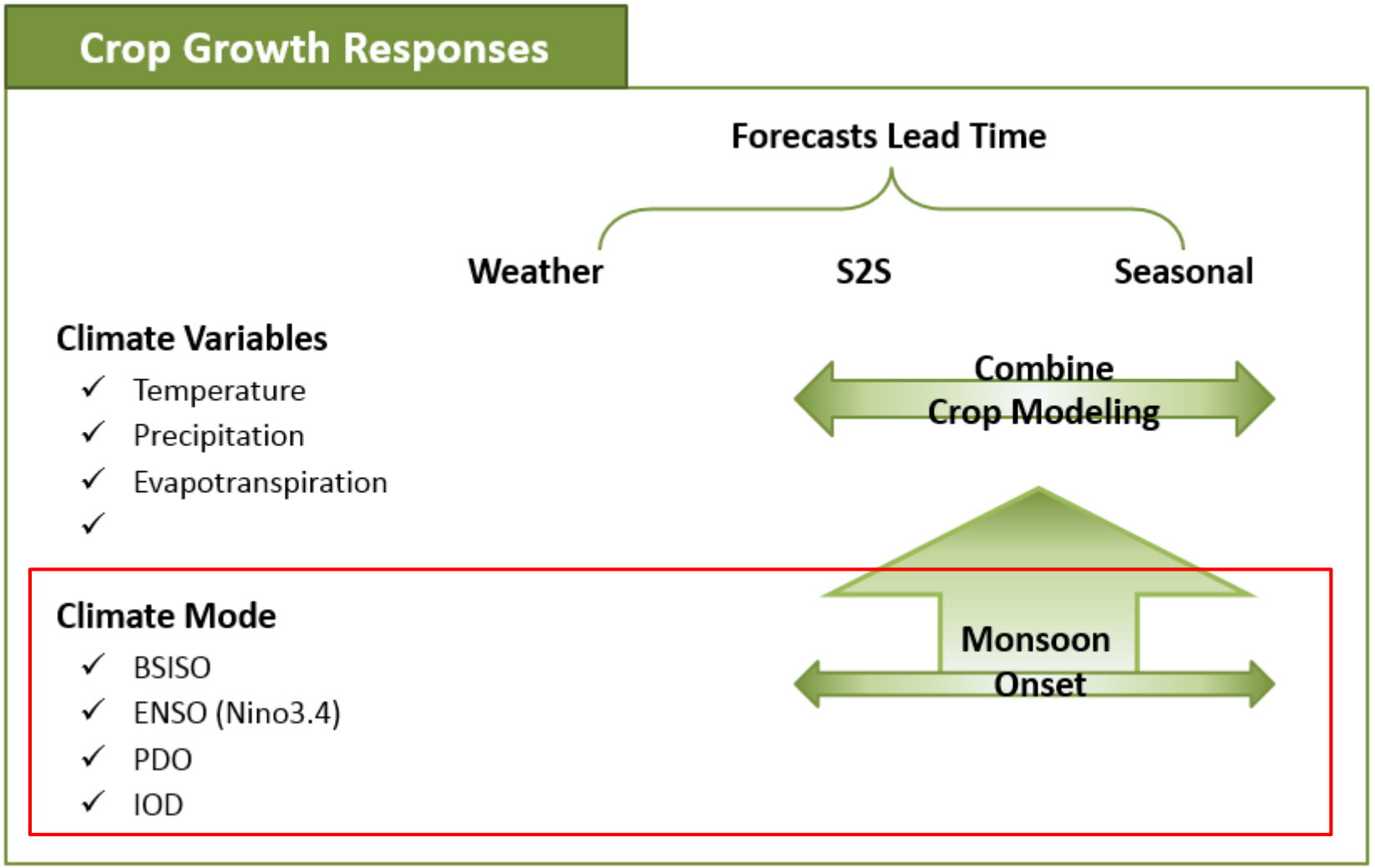
Next Challenges

- Sub-Seasonal to Seasonal (S2S) forecast
  - ✓ produce more various climate variables at “Daily level” ,
  - ✓ such as solar radiation including maximum and minimum temperature
  - ✓ Various model ensembles (e.g., ECMWF etc.)



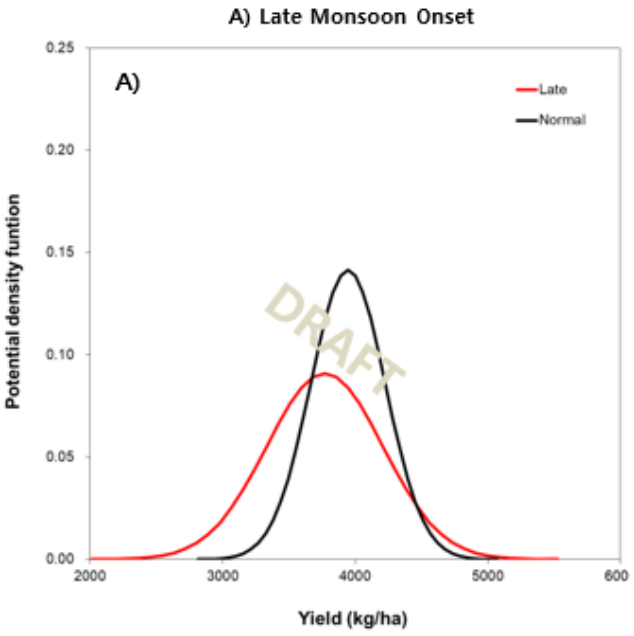
Next Challenges

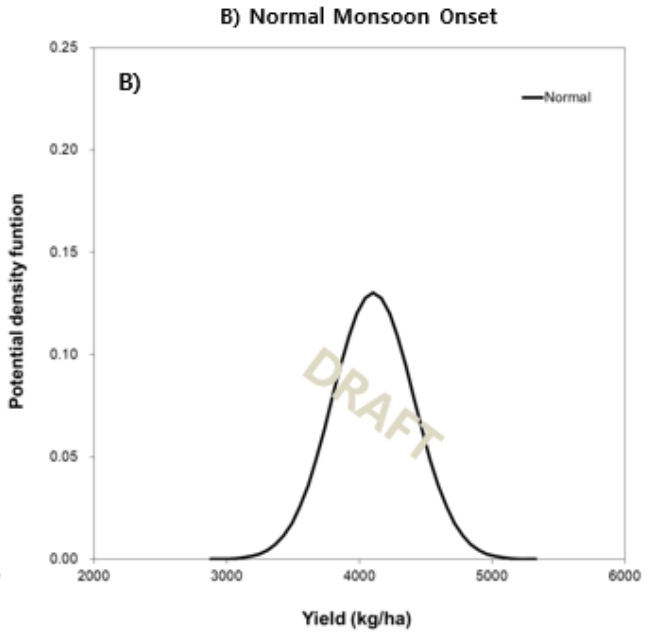
Crop Growth Responses

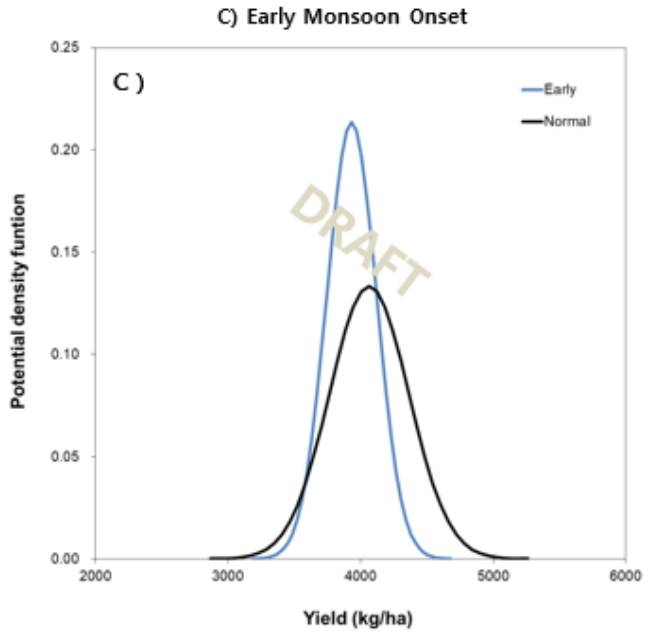


Next Challenges

- Probabilistic potential yield prediction
  - ✓ Combine Monsoon Onset Prediction (*late, normal, and early*)
  - ✓







Acknowledgement

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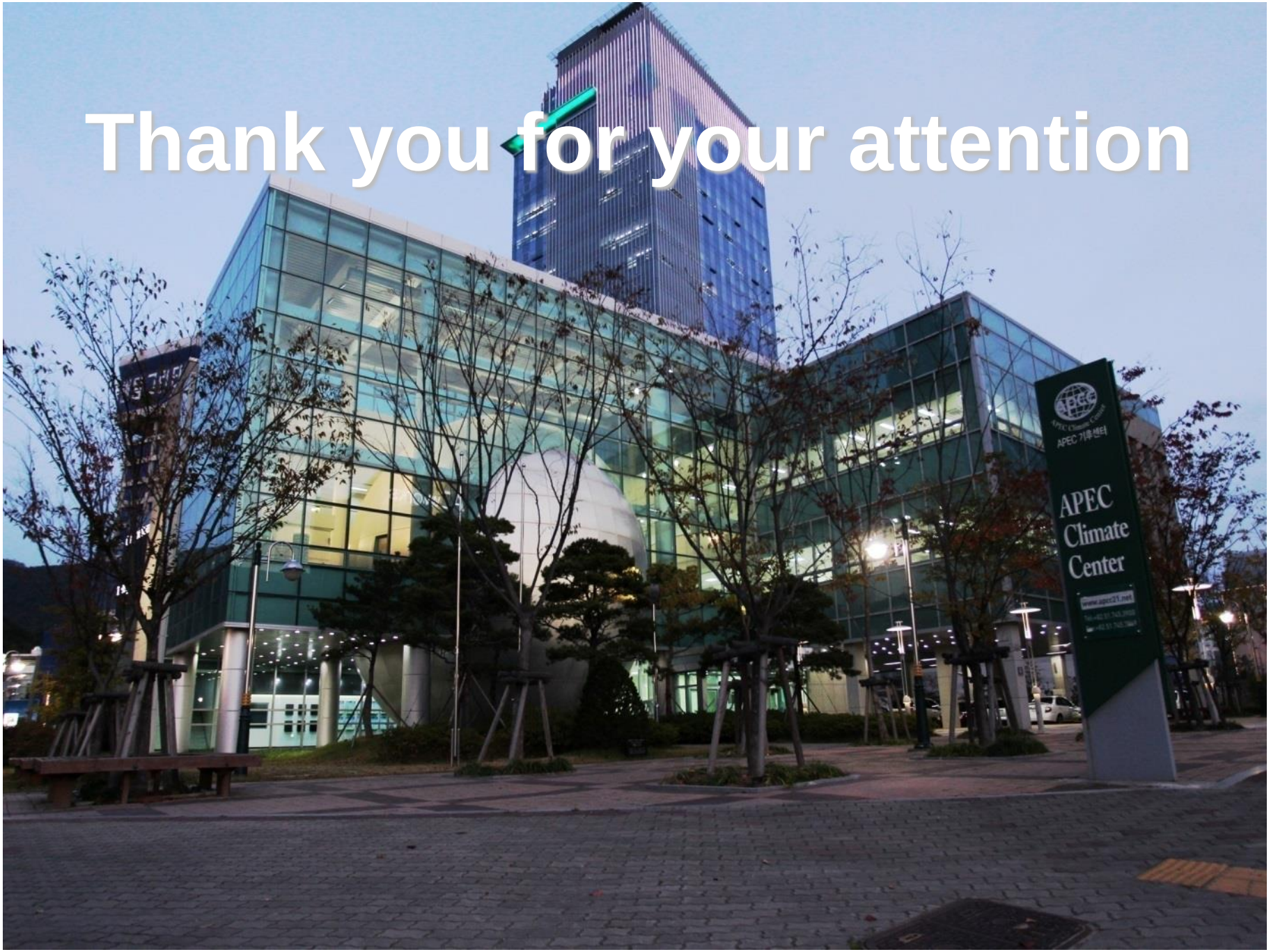
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