문서번호 APCC-출장-17-0358(2017-04-06)

TRAVEL REPORT FORM
출장보고서

결재	부서장	원장		
	04/05 유진호	04/06 정홍상		
협조	연구원			
	04/06 이수경			

I. Reporter 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
기후예측본부 응용사업본부	본부장 연구원	유진호 이수경	3/20-24	

II. Major Activities 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- 회의 참석 및 발표 등

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

- 첨부파일 참조

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

InterMet Asia & Extreme Weather Expo 출장보고서

□ 개요

아시아, 태평양 지역의 공공 및 민간부문 기상, 기후서비스 공급자, 분야별 수요자와 Donor들이 참석하는 Exhibition 및 Conference

○ 일시 및 장소 : 3/21-23, 싱가포르 Suntec city

○ 출장자 : 유진호 (기후예측본부), 이수경 (응용사업본부 사업기획팀)

○ 주요 참석기관 : World Bank (David Rogers 등), UNDP, WMO, 영국, 뉴질랜드, 일본, 한국 기상청 등 공공기관, Weather Company (IBM), Accuweather, Panasonic, Spire, Barron, Vaisala 등 날씨회사 및 Allianz, SwissRe 등 금융회사.

□ 주요활동

○ Main Conference invited speaker 및 World Bank GFDRR special session 토론 panel (유진호)

○ Weather Risk Management Symposium 등 동시개최 이벤트 참석 (이수경)

□ 주요 행사 개요

1) Main Conference "Building resilience and adaptability to extreme weather and Public-private sector co-operation

2) Weather Risk Management Symposium

3) World Bank GFDRR special session (22~23) "Public-private sector co-operation in the provision of forecasting services"

4) Technical presentations (미참)

5) Baron workshop on "Flood and Tropical Events: Tools and Technology for Mitigating Extreme Weather"(미참)

□ 논의 내용 및 시사점

- 공공 및 민간부문에서 개발되는 날씨관련 기술에 관한 발표와 공공-민간간 협력에 대한 발표 및 토론이 이어짐

- 일반적으로 공공부문은 기본적인 기상관측 및 연구개발과 그에 기반한 수치예보 등 대규모 재원과 인력이 투입되는 업무를, 민간은 공공부문에서 생산한 기초자료를 이용해 사용자에 맞춤형으로 제공하는 서비스 업무를 중심으로 역할 분담이 되어옴.

- 다만 관측기기의 개발은 민간부문을 중심으로 이루어져 왔으며 이에 대한 표준을 정하고 관리하는 역할을 WMO를 위시한 한 공공영역에서 수행함.

- 최근 민간회사에서 위성관측자료를 생산, 제공하거나(Spire Inc.) 수치예보 자료를 생산(Panasonic Weather Solutions)하는 등, 공공부문의 영역이라고 여겨지던 분야에 민간이 진출하게 되어 민간-공공 부문간의 역할 제정립의 필요성이 대두됨. 동시에 영국이나 호주 기상청과 같이 자체 수익 창출의 필요성이 있는 공공기관 역시 나타나고 있음.

- 또한 국가마다 다른 data policy와 기본적으로 무한 제공을 전제로 한 WMO resolution 40의 해석과 적용도 이슈가 됨.

- 공공 부문은 전반적인 funding의 감소, 민간부문은 작은 시장의 불안정성에 기인한 위험요소를 가지고 있어 Global Weather Enterprise의 성장을 위해서는 양자간 협력이 무엇보다도 필요하다고 판단함.

- 반면, 금융쪽에서 Indexed Insurance 등을 통해 날씨관련 시장으로 영역을 확장하고 있으며 이는 예측 정보에 기반한 consulting 혹은 맞춤형 정보 전달 등의 서비스 제공이 아닌 과거 관측자료를 이용한 상품들로 다양한 분야로의 확장 및 안정성이 높은 것으로 판단됨 : 즉, 기후정보 활용에서 예측보다 과거 관측에 기반한 정보 생산을 먼저 고민할 필요가 있음.

- 한편 개도국에서는 상대적으로 특히 열악한 민간 부문의 역량 또는 시장 규모로 인해 선진국과는 다른 이해관계를 가짐 : 공공기관이 대부분의 사업과 서비스를 주도할 수 밖에 없는 상황이며 그 공공기관 자체의 역량 개선도 시급함. (AccuWeather 같은 회사에서 자체 경보를 생산 제공하고 있음. Complementary한 정보로 해석될 수 있으나 경보와 같은 중요성을 갖는 정보가 다양하게 제공되는 것에 대한 검토는 필요함)

- 농업과 같은 기후 민감 분야라고 하더라도 Subsidy가 있는 경우 시장이 크게 왜곡되어 science based decision making 이 이루어지기 어려움. 실제 impact있는 기후정보의 활용을 위해서는 대상 국가나 지역의 정부 정책에 대한 충분한 사전 조사가 필요함.

- 공공-민간 부문의 효과적인 협력을 위한 논의의 장과 상호 인식과 문화의 전환이 필요함.

<별첨> GFDRR session 논의 결과 및 recommendation (WMO에 제출 예정)

Summary and Recommendations of the GFDRR Special Sessions at InterMET Asia, 22-23 March 2017, Singapore

Summary

The weather, water and climate enterprise is a vital part of the global community's efforts to protect life and property and increase prosperity. The public, private and academic sectors, which comprise this enterprise, are all keen to stress their contribution to this goal. When severe weather forecasts and warnings are acted on, loss of life is reduced and property and livelihoods are protected; longer-term forecasts enable better planning taking full account of climate variability and change. Tailored forecasts enable better financial decisions, increased efficiency, which improves economic performance. Research and development underpins improvements in models; new technologies improve observations and operational concepts.

Fundamentally, the ability to protect everyone and achieve sustainable social and economic development everywhere depends on the full engagement of all of three sectors.

At InterMET Asia 2017, the Global Facility for Disaster Reduction and Recovery (GFDRR) convened special sessions to explore ways National Meteorological and Hydrological Services (NMHSs), academia, and private companies could exploit opportunities and reduce obstacles to strengthening the enterprise. Representatives of all sectors were invited along with development partners and the World Meteorological Organization (WMO). Participants are listed in Annex 1. The sessions were held under the Chatham House Rule to facilitate an open and unrestrained dialogue. The complete agenda is in Annex 2. The special sessions comprised four parts: an overview from key stakeholder groups; a panel focusing on opportunities for public, private and academic sector engagement in developing and developed countries; a panel focusing on the obstacles; and a roundtable aimed at a way forward to address the issues raised in the preceding dialogues.

The discussions touched on the following issues:

- The need to grow the enterprise to meet the demands of society;
- Recent developments in the public and private sectors in meteorology; including in (i) science and technology as well as in forecasting services, and (ii) the relationship between key operational service agents such as national met agencies, private sector providers, development partners and the World Meteorological Organization (WMO);
- Ways in which better public-private sector collaboration could benefit the weather, water and climate enterprise;
- Obstacles that exist now or in the future that might get in the way of beneficial collaboration and partnerships;
- Ways to overcome the obstacles and enable society to capitalize on the capacity and capabilities of the public and private sectors to sustain, strengthen and build the weather, water and climate enterprise;
- Changing the public and private sector perceptions of each other; including the role of the WMO in facilitating this change;

- Mechanisms for partnership including the role of better regulation, legislation and clarity in the respective roles and responsibilities of the public and private sectors; opportunities for a regulatory framework for the provision of meteorological and hydrological services and the implications for providers, development partners and the WMO;
- the impacts of the enlarging role for the private sector and of increasing public-private sector cooperation in developing countries, Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

Recommendations

1. It was agreed that improving the engagement and co-operation between the public and private sectors[1] in meteorology would be advantageous to all in the community. Furthermore, a goal should be to create a partnership between the public and private sectors. To do so, a number of steps should be taken as outlined in this summary document.

2. The concept of an inclusive global weather enterprise (GWE)[2] involving all public and private sector stakeholders/actors was fully supported. Given the recent evolution and likely future evolution of the GWE, it was felt that a Strategy for the GWE should be developed that includes the public-private partnership. It was recognized that the public and private sectors share a common mission to save lives, protect property and enhance economic development. Reaching all those affected requires substantial expansion of the GWE. A common vision for this Strategy was discussed and it was proposed that the global weather enterprise should have the goal to grow by a factor of 10 over the next 10 years to increase its effectiveness and maximize its benefits to society. This ambitious goal would involve growth that would be fuelled by several factors including: greatly increased societal need for more accurate and reliable forecasts, mobilisation of private capital, economic growth in many countries, stronger cohesive engagement between the public and private sectors, and scientific and technological advances.

3. Suitable forums should be created bringing the GWE together to develop and agree this Strategy, and also address any issues to be resolved regarding the public-private partnership. It would be appropriate and advantageous for the WMO to sponsor the Strategy development forums and in doing so the WMO is encouraged to further reach out to the private sector so that, on an equitable basis, all sectors in the GWE are embraced. Additionally, independent sponsors could be sought.

4. There is an urgent need for greater independent regulation, including processes such as accreditation, of the operational activities within the GWE so that the quality of inputs (e.g.

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[1] The term public and private sectors is intended to include all actors and stakeholders in the weather enterprise including companies, NMHS's, international organisations, universities and research institutes.

[2] Although applicable to the entire weather, water and climate enterprise, the discussion focused mostly on weather-related issues; therefore, for the purposes of this report, the enterprise is restricted to the Global Weather Enterprise.

observations) and outputs (e.g. weather forecasts) of the GWE can be rigorously quantified to provide user confidence in their quality. It would be natural for this to be managed at international level by the WMO but it would need to be implemented within national jurisdictions.

5. A culture change is needed within each of the sectors of the GWE such that trust, respect, and mutual support between the sectors becomes the norm. This will include developing new and integrated language that provides unambiguous and uncontentious descriptions of key concepts for use across the breadth of the GWE. This will go a long way to remove misunderstandings that are present now between the public and private sectors. A culture of respect and trust is needed..

6. The global observing system is a precious resource that underpins the enterprise and that is predominantly, but not exclusively, funded by governments. Today around 40 million observations are used per day for numerical weather predictions; however, current model resolution requires over 40 billion data points to be specified so that there are far fewer observations available than needed. This means that a substantial opportunity exists to improve forecast skill if the number of observations produced by the global observing system could be greatly increased. This opportunity can be exploited by using both public and private sector additional sources of observations. New business models must be developed to enable effective use of privately-supported data services that are consistent with WMO Resolution 40 with a goal for these to be paid for once and distributed either everywhere or to public weather service providers for public weather forecasting.

7. Modern weather forecasting relies on global numerical weather prediction. The necessary increases in resolution, model complexity, and ensemble size and the ability to utilise increased observation volumes requires a substantial increase in the high-performance computing used by the GWE. This can be achieved partly by so-called scalability advances as well as more rapid and effective uptake of new computing and networking technologies. Indeed, along with the observation volume, the size of the currently available computer resources is a limiting step to growing the GWE. The third essential ingredient for progress is increased scientific knowledge of the weather system and there is optimism that these advances will continue to be made judging by the current trends in knowledge generation.

8. The distinctive roles and responsibilities of the public and private sectors should be more clearly articulated to prevent confusion and unnecessary duplication. A case in point is the concept of a single authoritative voice that is held dear by NMHS's but which can be misinterpreted by others. As all weather-forecasts should be probabilistic there need be no conflict between a warning with appropriate risk-based wording and any particular forecast that is a member of the grand ensemble taken into account to produce that warning. Without societal understanding of probabilistic forecasting and its intrinsic uncertainties, apparent conflicts may arise in the minds of users. Resolving the perception of such conflicts is a pressing challenge for the GWE but certainly involves a step-change in communicating the underpinning principles of probabilistic forecasting to society.

9. Making high quality global predictions from advanced centres available to developing, least developed countries and small island states is a pressing need. The economic case for the

benefits of good weather forecasts in creating jobs and economic activity (as well as the benefits in preventing loss of life and property) needs to be articulated so that governments of developing countries can be persuaded to invest in and support meteorological capacity in their country. The goal of improving weather information within a country requires both investments within country to develop intelligent customers of NWP outputs as well as enhancements to global prediction capabilities by maintaining and developing national observations.

10. The use of advanced weather information to help create appropriate insurance, re-insurance and hedging instruments to manage weather-dependent risks is rapidly growing. This has the potential to both provide increased revenue for the GWE and to reduce people's and businesses exposure to financial, livelihood and infrastructure losses from weather hazards. This could become a major mechanism with weather information at its core to enhance development in the developing countries, LDCs and SIDS, contributing to ending extreme poverty and protecting income growth.

11. The GWE is today producing multiple weather forecasts from both public and private sources. These range from public weather forecasts, including those to protect life and property, to tailored outputs from numerical predictions for specific applications by businesses. To create an optimal market for weather forecasts and services it is essential to ensure there is a level playing field such that commercial arms of NMHS's and private companies can compete on equal terms. The production of public weather forecasts for the protection of life and property is most appropriate for NMHSs to carry out.

The Multi Model Ensemble (MME) seasonal prediction system of APEC Climate Center (APCC)

Jin Ho Yoo

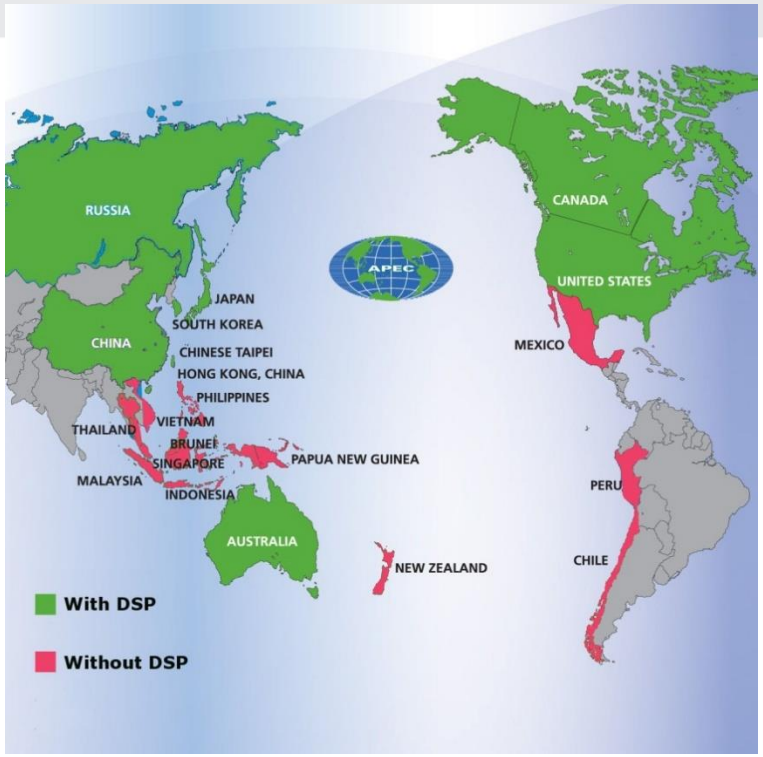
(APEC Climate Center)

APCC APEC CLIMATE CENTER

Contents

- What is it?
  - Background
  - Current operation
- How Good it is?
  - Performance of APCC MME SP
  - Pros & Cons
- How Useful it is?
  - Exercises in APCC
- Summary

APEC Climate Center



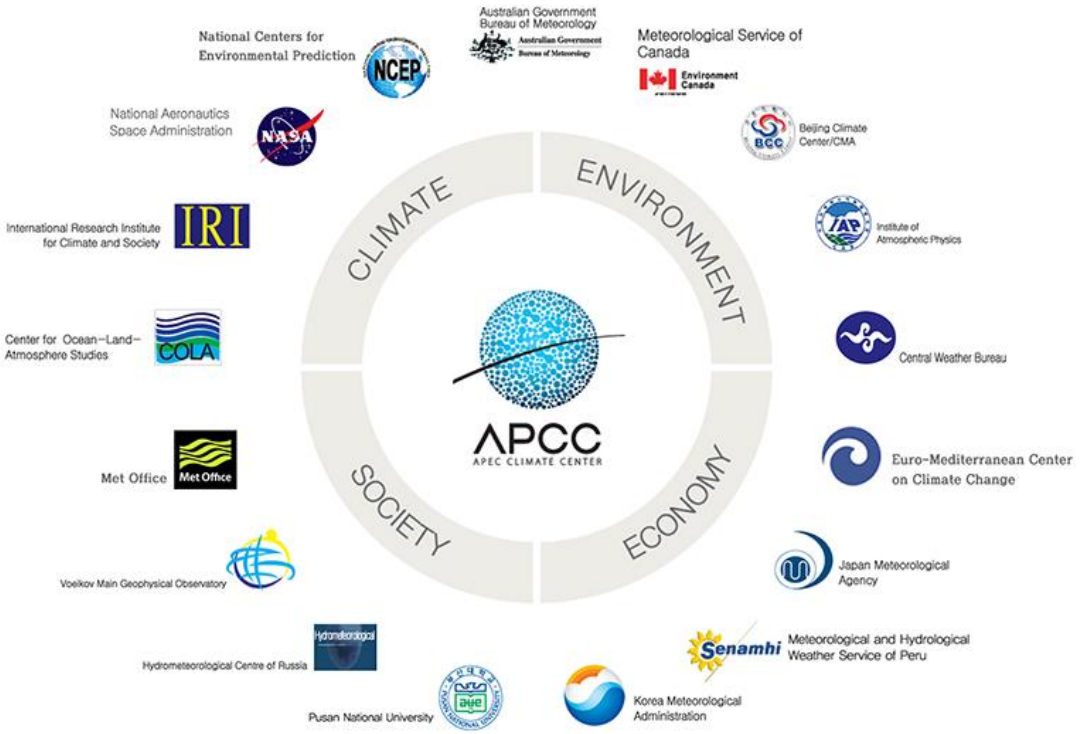
- 1998 –**APEC Climate Network** (APCN) was proposed at the 3rd APEC Science and Techonology Ministers Meeting in Mexico.
- 2004 – **APEC Climate Center** was proposed at the 27th APEC Industrial Science and Technology Working Group meeding in Singapore.
- 2005 –Establishment of APCC was **endorsed** at the 1st APEC Senior Officials Meeting in Korea.
- 2005. Nov. – APCC was established

Climate Prediction | Interdisciplinary Research | Climate Information Services | International Cooperation

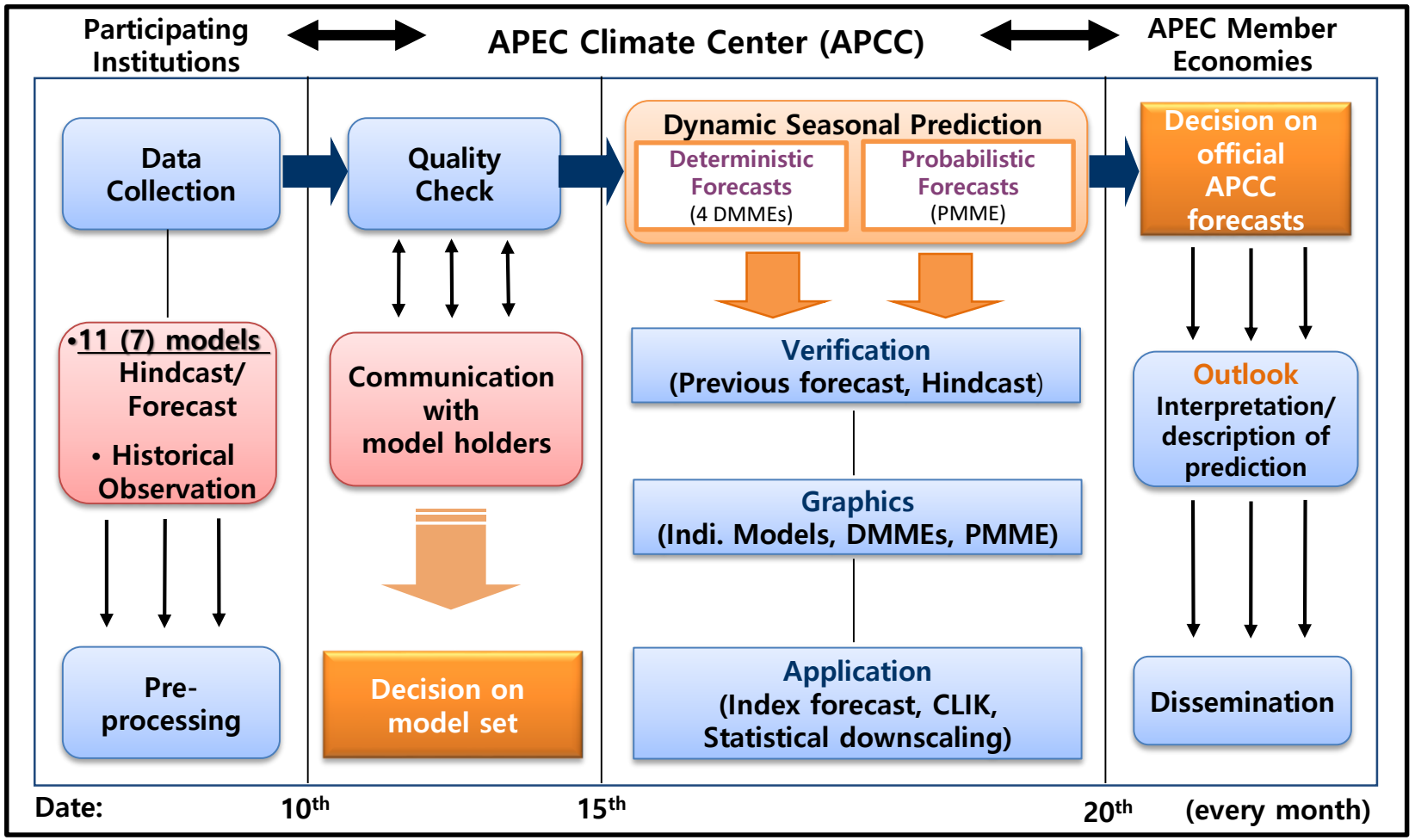
Multi Model Ensemble

Contributions from 16 organizations in ten countries

- 2006 : 3month Deterministic forecast (seasonal)
- 2007 : 3month Probabilistic forecast (seasonal)
- 2008 : 3month D/P forecast (monthly)
- 2013 : 6month D/P forecast

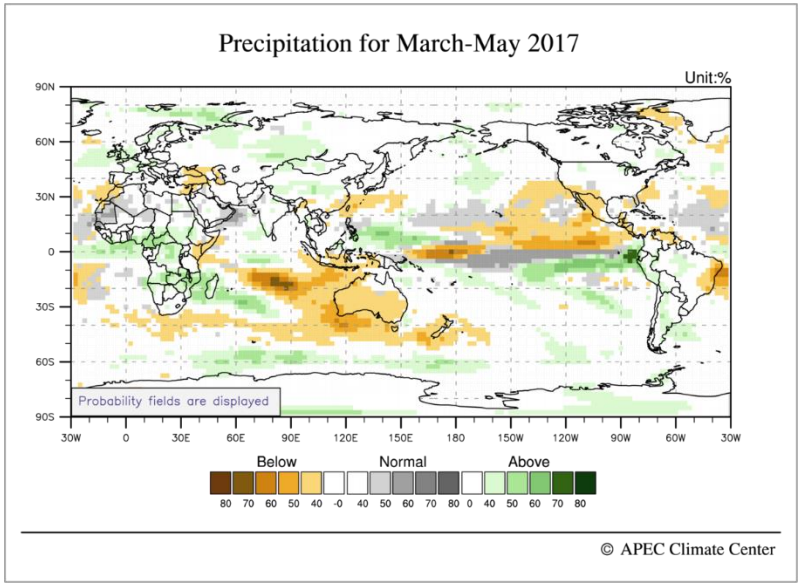


Current operation



Products

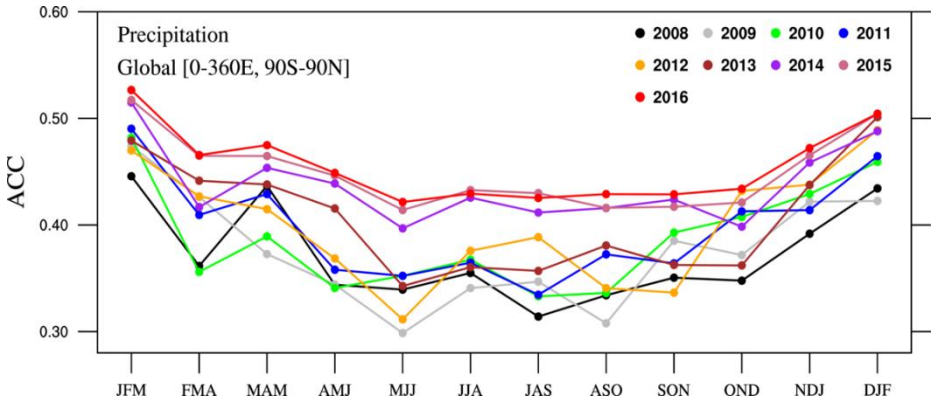
- Monthly & Seasonal mean forecast of Temp. Precip. T850, SLP, SST (deterministic & probabilistic)
- Verification results (hindcast, realtime)
- ENSO outlook
- Current conditions (drought, major indices)



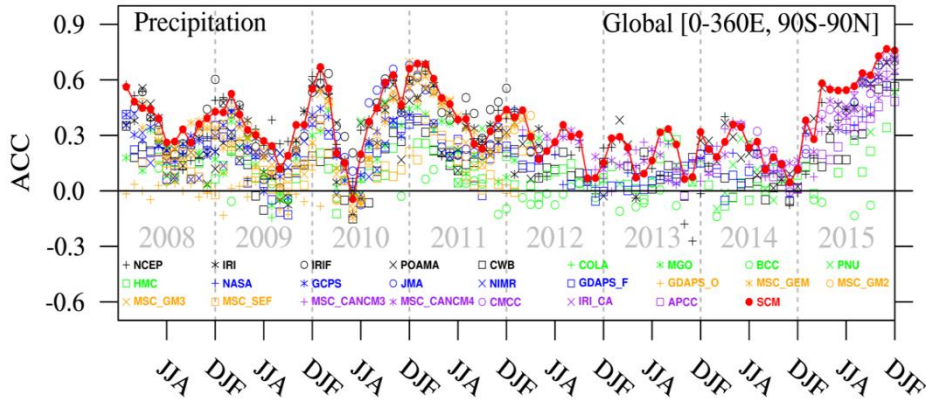
Dissemination via

- Email outlook
- Web page : www.apcc21.org
- APCC data service system (ADSS) : cis.apcc21.org
- Climate Information Toolkit(CLIK) : clik.apcc21.org

Performance of APCC MME



Hindcast Skill (ACC) of MME for past 9 years



Operational skill (MME and participants)

	APCC	A	B	C	D	E
AN	0.58	0.55	0.54	0.54	0.53	0.54
NN	0.52	0.52	0.54	0.52	0.52	0.52
BN	0.57	0.54	0.52	0.54	0.52	0.54

Realtime forecast skill (ROCs) of recent 5 yrs

One of the best forecast in predicting seasonal mean rainfall

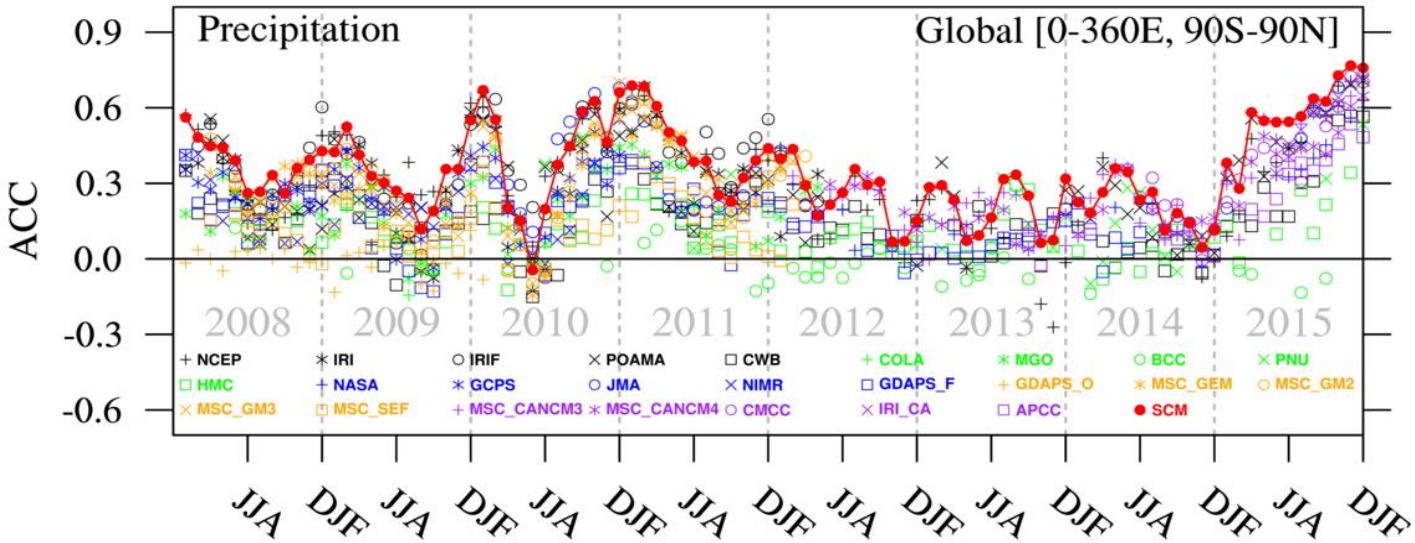
Why MME is better?

$$R_{MM} = \frac{\langle R \rangle}{\sqrt{V(\langle y \rangle)}} = \frac{\langle R \rangle}{\sqrt{\langle r \rangle}}$$

Average skill of all models

Inter-dependency among models

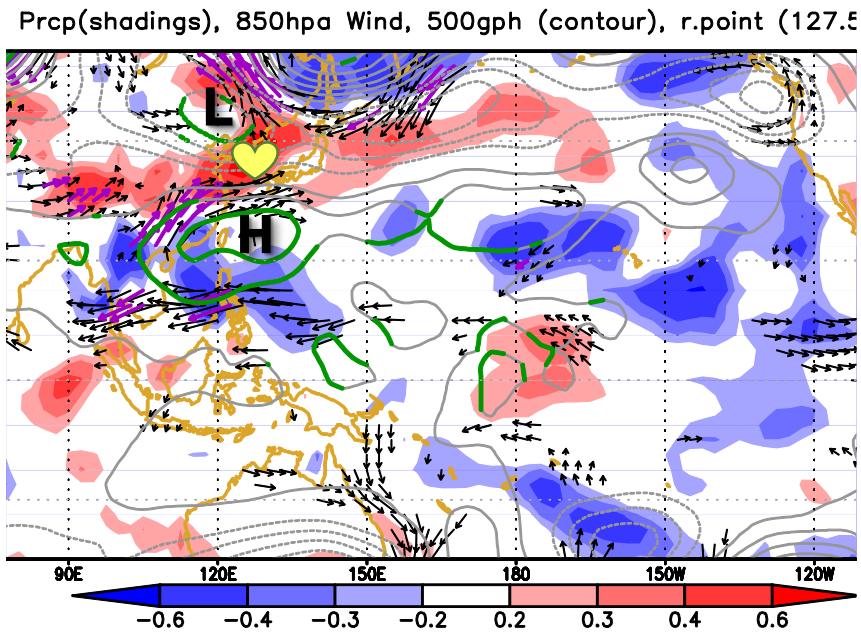
- Error cancellation
- Wider Prob. distribution



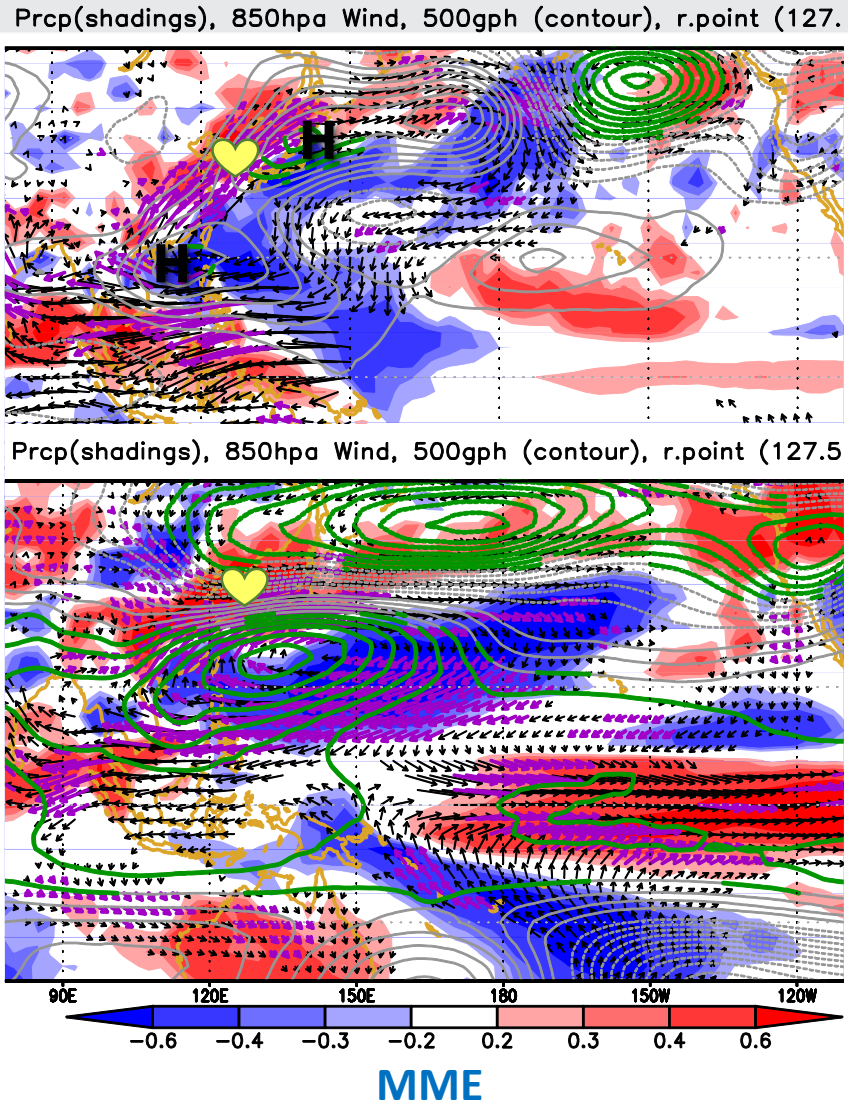
Not always but mostly similar to best performing model (changing)

Pros & Cons of MME

OBS



A Model

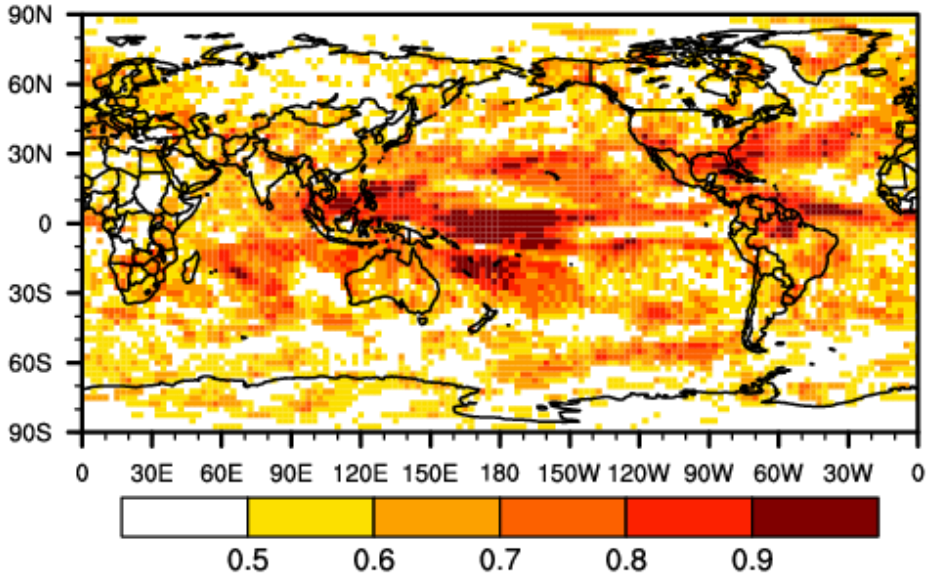


- Mostly predicting large scale patterns
- Less degree of freedom
- Good “in general” but forecast signal is weak (less confident)

MME

Utilization of Seasonal prediction

- Expectation : If you know the seasonal climate in advance, you can plan something
- Reality : If it is not certain, we won't buy it



ROC score (color : better than random guess)

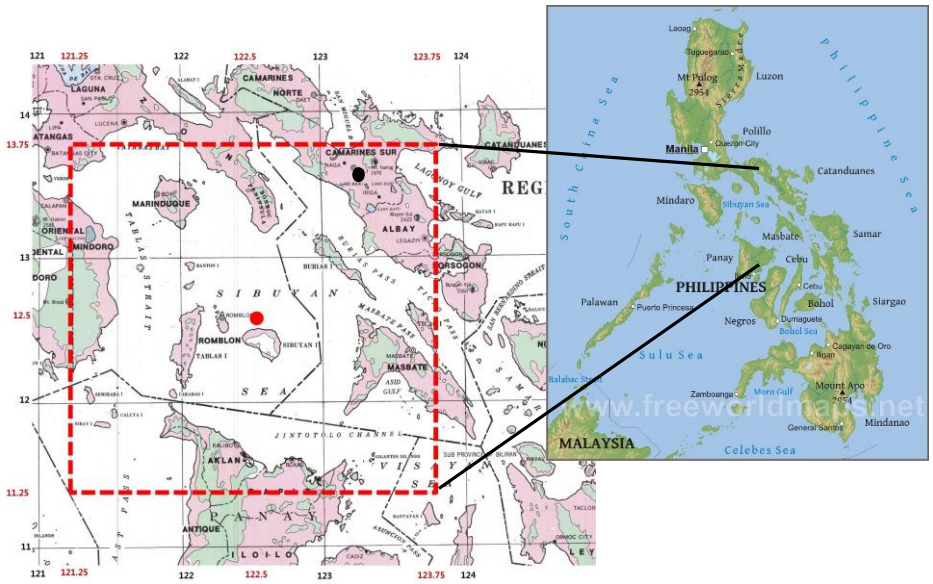
Seasonal prediction

↓

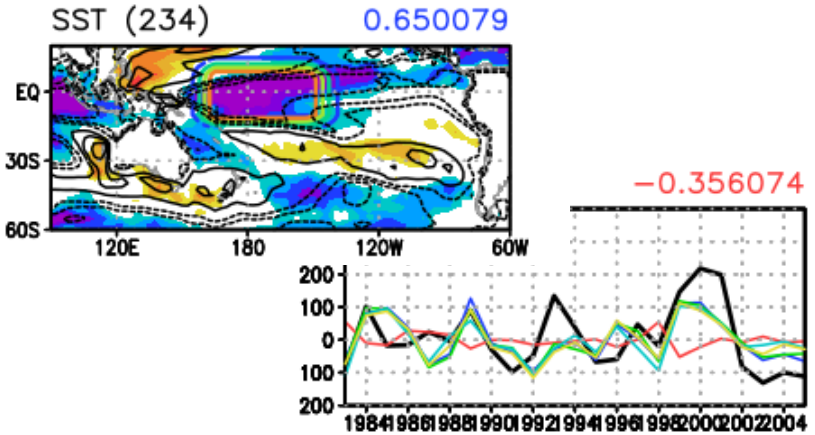
Decision making model

Scaling and Uncertainty

- MME is good at predicting large scale pattern
- Common biases of climate models exist
- Post-processing (downscaling) of forecast output is inevitable (cautions : not many samples)

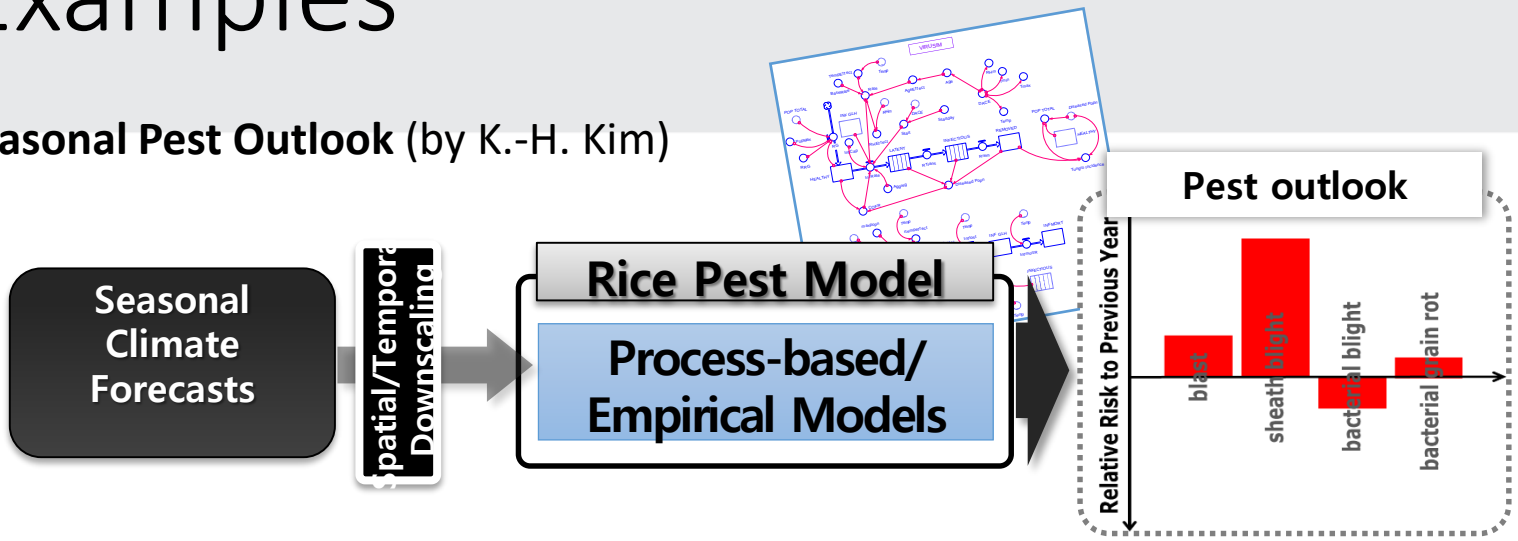


Post-processed forecast using MME SST prediction for Solomon Islands

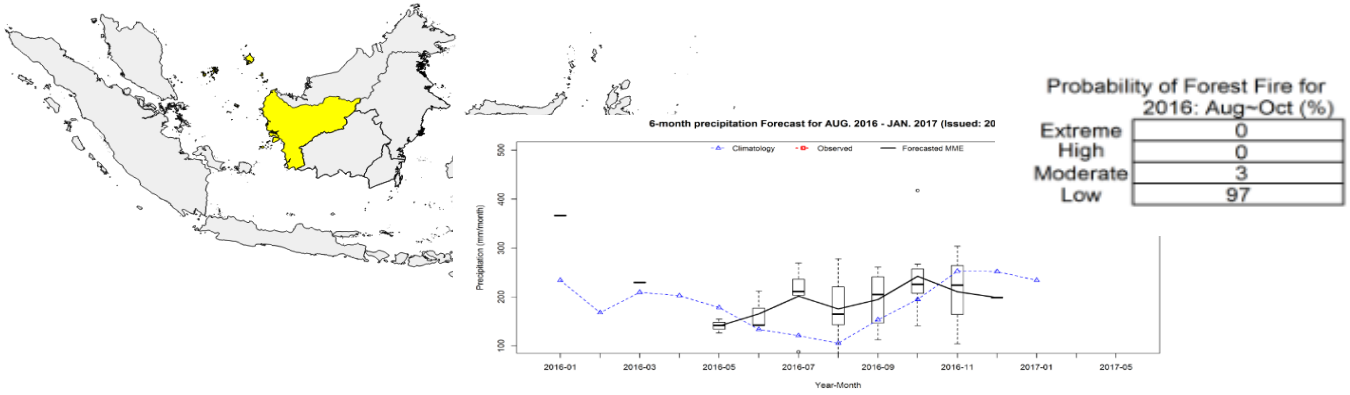


Examples

Seasonal Pest Outlook (by K.-H. Kim)



Forest Fire Early Warning (http://www.apcc21.org/ser/sea.do?lang=en), by J. Cho



Once a (few) year event : Hard to verify and quantify benefit

→ Packaging with weather information may be applicable (Ready - Set - Go)

Summary

- Multi Model Ensemble seasonal prediction is one of the most reliable seasonal forecast information at present
- Performance in predicting large scale rainfall patter has been improved (at least better than random guess in many region of the world)
- To use seasonal prediction in decision making, however, additional "tailoring" should be considered : another big challenges in climate science
- Patience and communication, Packaging

Thank you

jhyoo@apcc21.org

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