行政院所屬各機關出國報告

（出國類別：開會）

參加「2023 APCS and APCSW Joint Conference 籌備會議」心得報告

服務機關：交通部中央氣象局
姓名職稱：洪景山主任、陳孟詩簡任技正
派赴國家/地區：韓國
出國期間：**112** 年 **6** 月 **5** 日至 **6** 月 **7** 日
報告日期：**112** 年 **8** 月 **15** 日

摘　要

亞太經合會氣候中心（APEC Climate Center，APCC）為亞太經合會（Asia-Pacific Economic Cooperation，APEC）所成立的氣候預測中心。亞太經合會氣候中心的宗旨在為亞太經合會經濟體建立一個制度化的溝通管道，每年固定舉行氣候論壇（APEC Climate Symposium，APCS），以有效地交流區域氣候預測訊息，用以實現亞太經合會的理想：「透過增強區域繁榮的經濟機會，減少經濟損失，保護人民生命財產安全。亞太經合會氣候中心」。

中央氣象局（以下簡稱本局）為推動氣候服務，並拓展國際參與，同時深化本局與APCC 之間的合作，雙方於 2016 年 10 月簽署合作備忘錄（Memorandum of Understanding，MOU），並共同舉辦健康領域之氣候服務國際研討會（CWB-APCC Workshop on Climate Service for Health），之後亦分別於 2019 年及 2021 年共同舉辦氣候預測國際研討會（2019 International Workshop on Climate Prediction – Past, Present and Future）及亞太氣候服務國際研討會（Asia Pacific Climate Service Workshop 2021 – Climate Service for Resilience and Sustainable Development Towards a Net Zero Emission World）。

本局每 2 年舉辦一次亞太氣候服務國際研討會（Asia Pacific Climate Service Workshop，APCSW），本 (2023) 年度正規劃研討會相關細節，APCC 邀請本局將上述 APCS 與 APCSW 合併，舉辦「2023 APCS and APCSW Joint Conference」，時間暫訂為 2023 年 10 月 17 日至 20 日。臺灣為亞太經合會的正式會員，此次本局與 APCC 共同舉辦「2023 APCS and APCSW Joint Conference」，可擴大臺灣與亞太經合會會員國的互動及國際能見度。

為達成會議圓滿順利完成的目標，APCC 邀請本局面對面洽談會議籌備相關事宜及確認細節。此次出訪係就氣候監測預報、研究發展、氣候服務及國際合作等議題與 APCC 的專家學者互動，進行意見交流與經驗分享，尋求進一步深化交流合作的機會。

目　次

一、目的

APCC 前身為 APCN（Asia-Pacific Climate Network），於 2005 年正式成立，中央氣象局（以下簡稱本局）為創始會員之一。目前共有 11 個國家的 15 個主要氣候預報中心和機構（圖 1）產製季節模式預報資料，透過多模式系集技術整合為未來 6 個月 3 分類機率預報，提供給 APEC 會員經濟體及太平洋島嶼國家參考。APCC 亦為全世界唯一提供北半球夏季季內振盪（Boreal Summer Intra-seasonal Oscillation，BSISO）預報的機構，目前只有美國環境預測中心（National Centers for Environmental Prediction，NCEP）、歐洲中期天氣預報中心（European Centre for Medium-Range Weather Forecasts，ECMWF）、澳洲氣象局（Bureau of Meteorology，BOM）及本局（Central Weather Bureau，CWB）提供模式預報資料參與 BSISO 預報，本局的季節模式預報資料亦提供給 APCC 參與多模式系集預報。APCC 每兩年召開一次模式提供者會議（Model Provider's Meeting），對模式未來發展進行討論及交換意見。

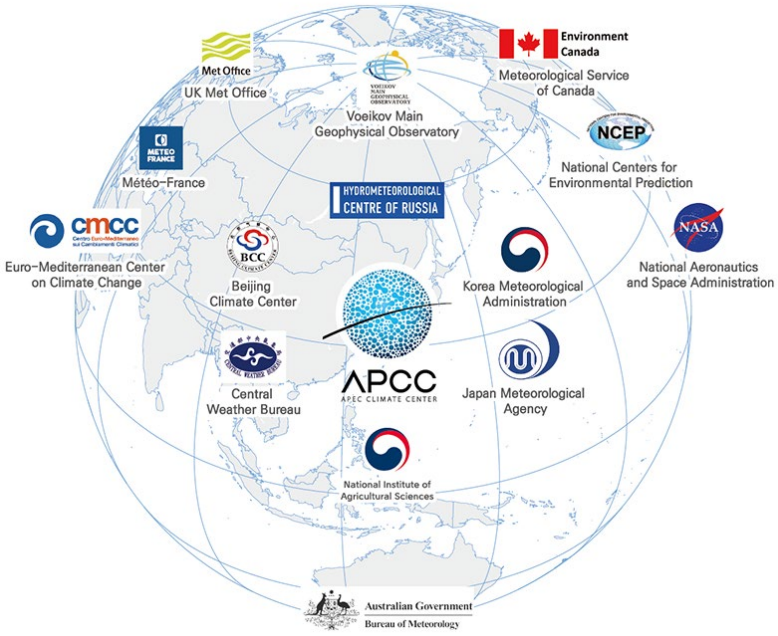


圖 1、參與 APCC 多模式系集預報的 15 個主要氣候預報中心和機構。

本局每月提供季節模式預報資料，自 2006 年起，除了 2020 年因疫情停辦外，每年均派員參加 APCC 舉辦的氣候論壇（APEC Climate Symposium）（表 1）。

表 1、歷屆 APCC 氣候論壇舉辦地點及主題

年份	地點	主題
2006	南韓	Implementation of APEC Climate Center for Climate Information Services
2007	南韓	Operation of APEC Climate Center for Climate Information Services
2008	祕魯	APEC Climate Center for Climate Information Services to Society
2009	新加坡	APEC Climate Center for Climate Information Services to Society
2010	南韓	Building Adaptive Capability to Extreme Climate Events through Networking among APEC Economies and Relevant Organizations and Projects
2011	美國	Harnessing and Using Climate Information for Decision Making
2012	俄羅斯	Harnessing and Using Climate Information for Decision Making: An In-Depth Look at the Agriculture Sector
2013	印尼	Regional Cooperation on Drought Prediction Science to Support Disaster Preparedness and Management
2014	中國	Managing Climate Extremes and Hydrologic Disasters: Scientific Prediction and Emergency Preparedness
2015	菲律賓	The use of Weather and Climate Information for Efficient Disaster Risk Management
2016	祕魯	Smart Climate Information and Accountable Action: Achieving Sustainable Food Security in a Changing World
2017	越南	Building Resilient Agro-Food Systems from Production to Consumption: for Sustainable Food Security using Climate Information
2018	巴布亞紐幾內亞	Overcoming the Challenges of an Uncertain Future with Enhanced Climate Information and Services
2019	智利	Pathway to Sustainable Growth under a Changing Climate: Enhancing Interaction between Climate Science and Society
2021	線上	Innovations in Climate Communication for Enhancing Human Security to Manage Risks of Climate Extremes
2022	泰國	Enhancing APEC Resilience through AI Applications in Climate Change Adaptation

自 2008 年起，APCC 氣候論壇舉辦地點均為當年度 APEC 會議地點，僅 2010 年除外（當年度 APEC 會議地點為日本）。會議主題由早期著重於氣候領域，逐漸擴展至跨領域（如農業、防災、水資源、糧食安全）的應用，扣合 WMO 倡議的全球氣候服務框架（Global Framework for Climate Service，GFCS）五大優先領域（農業與糧食安全、防災、能源、健康、水），近年來延伸到氣候變遷調適、永續發展甚至人工智慧，由此可見隨時代演變所關注的焦點也隨之改變。除氣候論壇外，APCC 自 2015 年起亦在氣候論壇前後同步舉行工作小組會議（Working Group Meeting），由各會員經濟體之氣象主管機關副首長或其授權人員參加，報告年度工作並進行意見交流。

本局與 APCC 一直保持密切的合作關係，雙方於 2016 年 10 月簽署合作備忘錄，並共同舉辦健康領域之氣候服務國際研討會（CWB-APCC Workshop on Climate Service for Health），之後亦分別於 2019 年及 2021 年共同舉辦氣候預測國際研討會（2019 International Workshop on Climate Prediction – Past, Present and Future）及亞太氣候服務國際研討會（Asia Pacific Climate Service Workshop 2021 – Climate Service for Resilience and Sustainable Development Towards a Net Zero Emission World）（圖 2），該 2 次國際研討會皆邀請國際上相關領域之知名學者專家發表演講，不僅為該研討會討論主題指引未來的發展方向，同時也協助建構本局人員的專業能力並擴展國際視野。

除了共同舉辦研討會之外，本局與 APCC 亦透過專家學者互訪方式進行交流，2018、2019 連續兩年邀請 Dr. Hae-Jeong Kim 來局訪問，2018 年本局亦多次派員參加 APCC 所舉辦的訓練課程，主題包括季內至季節預報（Subseasonal to Seasonal Training Program）、農業及水資源領域以使用者為導向的統計降尺度氣候資訊（Training Program on “User-oriented Statistical Downscaling of Climate Information in Agriculture and Water Resources”）、氣候資訊工具（Training Workshop on Climate Information Tool Kit）等，後因疫情暫時中斷實體互訪。

本局規劃每 2 年舉辦一次亞太氣候服務國際研討會（APCSW），本 (2023) 年度正規劃研討會相關細節，基於過去的合作經驗，APCC 邀請本局將上述 APCS 與 APCSW 活動合併辦理，舉辦「2023 APCS and APCSW Joint Conference」，時間暫訂為 2023 年 10 月 17 日至 20 日。臺灣為亞太經合會的正式會員，此次本局與 APCC 共同舉辦「2023 APCS and APCSW Joint Conference」，可擴大臺灣與亞太經合會會員國的互動及增加國際能見度。

為共同舉辦「2023 APCS and APCSW Joint Conference」，先前雙方已多次透過線上會議方式討論想法，惟仍有諸多研討會籌備細節仍需當面溝通尋求共識，因此本局應 APCC 邀請前往韓國，除確認研討會籌備細節外，同時也拜訪去年甫上任之 APCC 執行長 Mr. Do-Shick Shin，並進一步與 APCC 重要幹部進行交流，以尋求深化雙方未來合作的機會。

圖 2、上：2016 年健康領域之氣候服務國際研討會；下：2019 年氣候預測國際研討會。2021 年亞太氣候服務國際研討會因疫情改為線上舉辦。

二、過程

本次出國期間除參加「2023 APCS and APCSW Joint Conference 籌備會議」外，同時也與 APCC 學者專家就氣候監測預報、研究發展、氣候服務及國際合作等議題進行意見交流與經驗分享，共同參與討論者亦包括我國國際氣候發展智庫（International Climate Development Institute，ICDI）趙恭岳執行長及中華經濟研究院（Chung-hua Institution for Economic Research，CIER）林桓億主任。行程安排及工作摘要如表 2：

表 2、本次出差行程安排

日 期	工作摘要
2023 年 6 月 5 日	赴韓國釜山，拜會駐韓國台北代表部釜山辦事處及 APCC 執行長
2023 年 6 月 6 日	與 APCC 重要幹部研議 2023 APCS and APCSW Joint Conference 相關細節
2023 年 6 月 7 日	與 APCC 專家學者討論氣候監測預報及研究發展、氣候服務及國際合作等議題，晚間搭機回臺

（一）、6 月 5 日

本次出國行程相當緊湊，早上班機 11:00 抵達釜山國際機場，經短暫用餐後馬上前往駐韓國台北代表部釜山辦事處拜會郭承凱處長 (圖 3)。郭處長過去在首爾任職，剛至釜山上任不久，此次除了禮貌性拜訪之外，也向郭處長說明臺灣和韓國氣象互動的往來，包括 APCC、韓國氣象廳（Korea Meteorological Administration，KMA）及韓國氣象科學研究所（National Institute of Meteorological Science，NIMS）等，同時也展望未來可能的合作及發展。此外也特別介紹 APCC Ms. Sangwon Moon 組長及 Ms. Suhee Han 給辦事處相關同仁認識，俾利辦事處和 APCC 後續的互動。會談中進一步爭取郭處長從外交的角度切入，多方協助促進臺韓氣象交流。郭處長則分享他在韓國對於推動臺韓科技合作的經驗，並允諾會極力提供必要的外交協助，讓本局及 APCC 共同舉辦的研討會能順利成功。郭處長及辦事處於晚間設宴，接待此次臺灣訪問團及 APCC 重要成員，為促進三方的互動留下圓滿的成果。

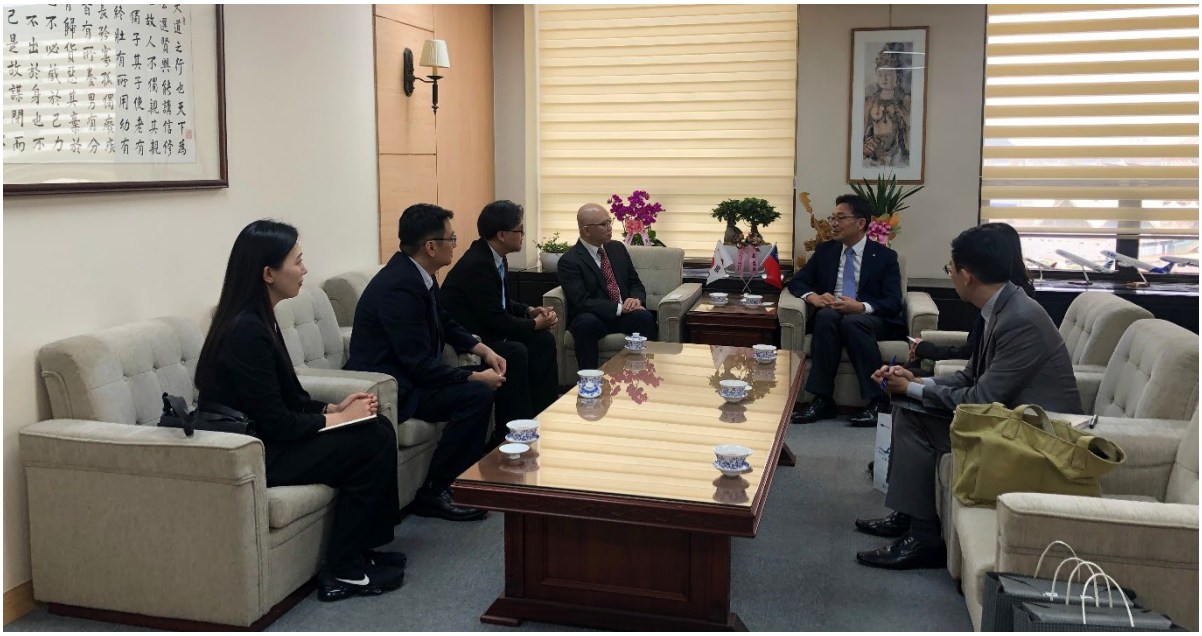


圖 3、上：拜訪駐韓國台北代表部釜山辦事處，由左至右分別為 APCC Sangwon Moon 組長、中華經濟研究院林桓億主任、中央氣象局陳孟詩簡任技正及洪景山主任、駐韓國台北代表部釜山辦事處郭承凱處長、國際氣候發展智庫趙恭岳執行長、APCC Ms. Suhee Han、駐韓國台北代表部釜山辦事處林保仁領事。

中：中央氣象局、APCC 拜會駐韓國台北代表部釜山辦事處。

圖 3 (續)、下：駐韓國台北代表部釜山辦事處設宴接待此次臺灣訪問團及 APCC 重要成員。

拜會完駐韓國台北代表部釜山辦事處後，下午 4:00 拜會 APCC 執行長 Mr. Do-Shick Shin (圖 4)，Mr. Shin 曾經訪臺數次，對於臺灣的印象非常好。此次拜訪，除特別感謝他支持本局與 APCC 共同舉辦 APCS/APCSW 研討會外，也再次強調本局和 APCC 過去堅定的合作關係和友誼。此外，我們說明本局即將改制為氣象署，屆時與韓國氣象廳之間可以有更全面的互動。最後，本局邀請他於 APCC/APCSW 研討會期間訪臺，並擔任會議主持人，Mr. Shin 欣然同意並表支持。

圖 4、上：拜訪 APCC，由左至右分別為 APCC Dr. Kyungwon Park、中央氣象局陳孟詩簡任技正、國際氣候發展智庫趙恭岳執行長、中央氣象局洪景山主任、APCC 執行長 Do-Shick Shin 及 Ms. Sangwon Moon、中華經濟研究院林桓億主任。下：中央氣象局洪景山主任和 APCC 執行長 Do-Shick Shin 互贈禮物。

（二）、6 月 6 日

本日針對今 (2023) 年即將共同舉辦的「2023 APCS and APCSW Joint Conference」進行細節討論（圖 5）。重點包括以下幾個面向：

1. 會議主題暫定為強化氣候變遷下的能源安全及韌性（Enhancing Energy Security in a Changing Climate for a Resilient Future），此議題正好契合我國目前全力推動 2050 淨零下能源轉型的政策。議程安排暫定如表 3。

表 3：「2023 APCS and APCSW Joint Conference」議程安排 (暫定)

<table>
<tr><td colspan="5">Theme: Enhancing Energy Security in a Changing Climate for a Resilient Future
Date ： October 17-20, 2023
Venue: International Conference Hall, Central Weather Administration, Taipei</td></tr>
<tr><th>Time</th><th>10/17(Tue)</th><th>10/18(Wed)</th><th>10/19(Thu)</th><th>10/20(Fri)</th></tr>
<tr><td>AM</td><td>Working Group Meeting
9:00-11:00</td><td>Opening
09:00-10:10
Keynote Speech
(two speakers, 45 min each)
10:30-12:00</td><td>Session III
10:00-12:00
(4 speakers, 25 min each
+ session Q&A and wrap-up)</td><td rowspan="2">Field study (Visit 2023 TWCAE event)
09:00-11:00

Farewell Lunch</td></tr>
<tr><td rowspan="2">PM</td><td>Mr. Shin leads APCC delegation to visit CWA
(60-min CWA tour + 30-min meeting w/ CWA Administrator)</td><td rowspan="2">Session I
13:00-15:00
(4 speakers, 25 min each
+ session Q&A and wrap-up)

Session II
15:30-17:30
(4 speakers, 25 min each
+ session Q&A and wrap-up)

Event Dinner Banquet</td><td>Panel Discussion
Moderator: Camyale Chao
13:00-15:00
(5-6 panelists)</td></tr>
<tr><td>VIP Dinner (5 APCC delegates)
18:00-20:00</td><td>Closing Remarks
Mr. Shin & Mr. Mark Cheng
15:00-15:15</td></tr>
</table>

2. 研討會時間訂為 2023 年 10 月 17 日至 20 日，於中央氣象局國際會議廳舉辦。會議以 Hybrid 方式，採線上及實體方式舉辦，包括三大部分（表 3），第一部分於 10 月 17 日舉辦 APCC 氣候論壇工作小組會議（Working Group Meeting），由各會員經濟體之氣象主管機關副首長或其授權人員參加，報告年度工作並進行意見交流，此為線上議程。第二部分於 10 月 18 日至 19 日舉辦「2023 APCS and APCSW Joint Conference」，共分為 3 個議程和 1 個綜合討論；第三部分則於 10 月 20 日參觀由國際氣候發展智庫舉辦的「亞太永續行動博覽會」。

3. 「2023 APCS and APCSW Joint Conference」內容包括：

- 關鍵演講：為了促進 2050 淨零目標下能源轉型之氣候服務的挑戰與機會（Challenges and opportunities of climate service to promote the energy transition for 2050 net-zero target），預計邀請 2 位講者。
- 議題一：應用氣候資訊強化能源安全（Enhancing energy security using climate information），預計邀請 4 位講者。
- 議題二：氣候變遷調適下的再生能源和潔淨能源（Renewable and clean energy to adapt climate change），預計邀請 4 位講者。
- 議題三：強化能源安全的最佳實務或政策（Best practices or policy efforts to enhance energy security），預計邀請 4 位講者。
- 討論：對氣候變遷調適下能源轉型與安全的討論及政策建議–挑戰與機會（Policy recommendations and discussion on energy system transition and energy security in the contest of climate change adaptation–what is our challenges and opportunities），預計邀請 5-6 位講者。

4. 分工細節

APCC 將爭取 APEC 贊助經費美金 12 萬元，APCC 和本局分別各提供美金 1 萬 5 千元和 3 萬元，本局並負責會議舉辦之場地布置、住宿交通安排等各項行政支援。APEC 贊助經費將用來邀請 14 位 APEC 會員經濟體參加人員及 12 位講者的機票和食宿。

本日討論之相關細節如附錄 1，後續規劃 APCC 將派員於 9 月 14 日至 16 日訪臺，確認研討會的最後細節，同時代表 APCC 參加中央氣象署掛牌儀式，表示雙方合作的堅定友誼。

圖 5、討論 2023 APCS and APCSW Joint Conference 籌備相關細節。

(三)、6 月 7 日

本日安排與 APCC 專家學者就雙方業務進行交流討論。APCC 組織架構如圖 6，參與的學者專家包括氣候服務與研發處（Climate Service and Research Division）處長 Ms. Jinyoung Rhee、氣候預報組（Climate Prediction Department）組長 Mr. Hyungjin Kim、氣候分析組（Climate Analysis Department）Dr. JinHo Yoo、預報研究組（Prediction Research Department）組長 Ms. Soo-Jin Sohn 及對外事務組（External Affairs Department）組長 Ms. Sangwon Moon、Ms. Suhee Han（圖 7）。

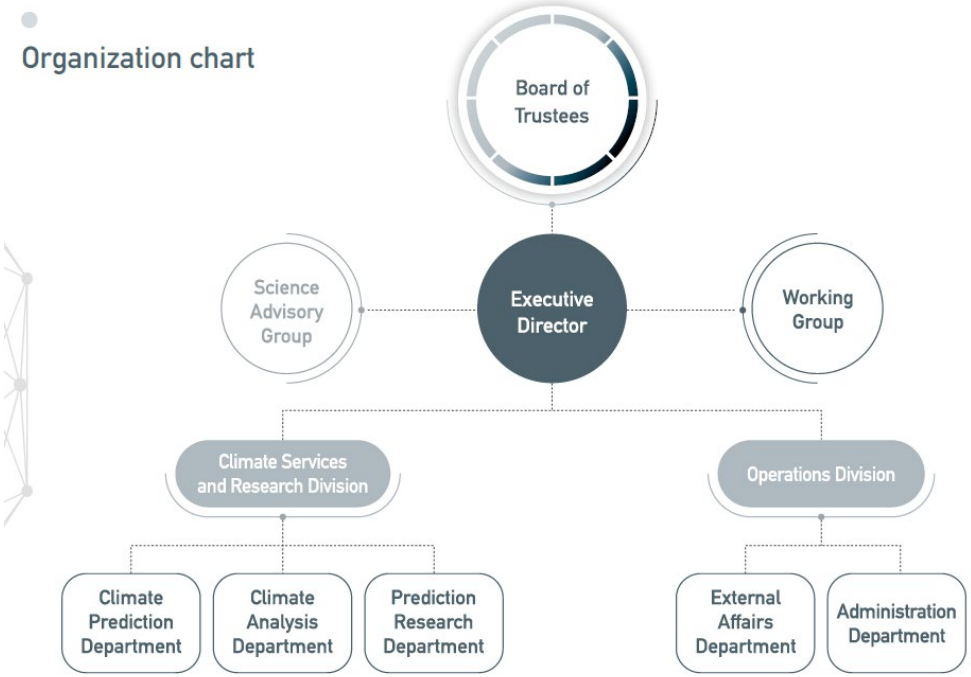


圖 6、APCC 的組織架構。

圖 7、與 APCC 專家學者進行交流討論。由左至右分別為 APCC 氣候預報組長 Mr. Hyungjin Kim、對外事務組 Ms. Suhee Han、氣候服務與研發處長 Ms. Jinyoung Rhee，國際氣候發展智庫趙恭岳執行長，APCC 氣候分析組 Dr. JinHo Yoo，中央氣象局洪景山主任及陳孟詩簡任技正，APCC 對外事務組長 Ms. Sangwon Moon、中華經濟研究院林桓億主任。

上午討論主題為「短期氣候預報的現況與未來展望」(圖 8)，首先由本局陳孟詩簡任技正進行報告，簡報資料如附錄 2。APCC 則由 Ms. Jinyoung Rhee 介紹 APCC 的氣候監測預報，重點摘錄如下：

1. APCC 扮演的角色：
   (1) APCC 是經過 APEC 認證的氣候預報中心。
   (2) APCC 支援韓國氣象廳氣候預報資訊及技術。
   (3) 聯合國氣象組織多模式系集長期預報標竿中心 (World Meteorological Organization Lead Center for Long-range Forecast Multi-model Ensemble, WMO LC-LRFMME)為韓國氣象廳 (KMA) 和美國國家海洋大氣總署（National Oceanic and Atmospheric Administration，NOAA）共同成立，APCC 協助 KMA 維持 WMO LC-LRFMME 網站的運作。
   (4) APCC 為 WMO 季內至季節預報（Subseasonal to seasonal，S2S）計畫國際協調辦公室（International coordination office，ICO）。

2. 2022 年的研發成果包括：
   (1) 改善東亞極端氣候的監測分析預報系統，以協助 KMA 發展極端事件早期預警。這部分的工作包括監測亞太區域極端事件，進行歸因分析，並透過機制研究發展預報指引。
   (2) 改善氣候預測模式的校驗系統，以支援韓國氣象科學研究所對氣候預測模式的評估及改進。
   (3) 發展以人工智慧（Artificial Intelligence，AI）為基礎的氣候預測科技，應用於未來 1 個月預報，也就是應用深度學習類神經網路（Deep Neural Network），利用 ERA-5 再分析資料進行訓練及驗證，再套入歐洲模式預測資料以產出 2 米溫度預報，並進行預報技術評估。
   (4) 發展亞太氣候資訊服務，提供予 APEC 會員經濟體、綠色氣候基金 (Green Climate Fund)、聯合國環境規劃署（United Nations Environment Programme，

UNEP）等進行運用。

3. 在季內預報方面，APCC 根據 BSISO 相位進行合成分析，發現在韓國入梅時赤道東印度洋對流增加、副熱帶西北太平洋對流減少，造成太平洋副熱帶高壓（以下簡稱副高）西伸，其西北側帶來暖溼西南風，因而造成降雨增加；相反的，當中印度洋對流增加、南海對流減少時，副高及滯留鋒面南移，因而造成韓國出梅。利用季內模式預測資料評估模式對 BSISO 可預報度最多可達第 3 週。

4. 在季節預報方面，APCC 開發多模式系集技術，也就是先確認氣候變異驅動因子在模式中具備可預報度，之後計算多模式系集結果，再應用模式後處理技術修正格點預報誤差，並使用統計降尺度方法得到在地化預報，其流程跟本局利用氣候模式資料產製季節預報產品類似。

5. 在氣候變遷推估方面，APCC 進行極端降雨與颱風變化研究。首先了解造成極端降雨的可能物理機制（如南亞高壓），計算未來百年才會發生一次的降雨增加率以及因副高改變造成的颱風活動變化，之後利用 CMIP6 計畫（WCRP Coupled Model Intercomparison Project）的 UKESM (UK Earth System Model) 模式推估資料計算颱風生成潛勢，發現在二氧化碳高排放情境下，中緯度太平洋海溫增加且垂直風切減弱，有利於颱風生成，增加侵襲南韓的機會，同時亦使用 CORDEX-EA 實驗（Coordinated Regional Climate Downscaling Experiment）的動力降尺度 25 公里解析度模式資料推估未來颱風影響韓國的頻率及強度變化。

6. 在模式發展方面，韓國的做法是學研機構開發氣候模式預報技術，再技術轉移至 KMA 進行上線作業，然而同樣存在著學用落差的問題，作業單位往往受限於量能不足，無法真正應用至預報作業。APCC 做為模式共同發展的氣候測試平臺（Climate Test Bed），嘗試建立 R2O（research to operation）技術轉移的架構，也就是發展模式的系統性診斷評估標準，以建立模式評比的客觀化決策基礎。換句話說，所有學研機構發展的氣候模式透過 APCC 開發的模式評估標準，進行系統性診斷評估及

準作業預報實驗，通過平行作業測試標準的氣候模式再轉移給 KMA 下的韓國氣象科學研究所 (NIMS) 進行實際運作，以促進氣候模式從共同開發到實際上線作業的效率。

綜合來說，氣象預報時間尺度涵蓋短中期天氣預報（1 小時、1 日至 2 週）、季內至季節預報（2 週至 2 個月）、長期預報（3 個月至 6 個月）、季節至年際預報（12 個月）以及氣候變遷推估（10 年以上）。APCC 負責的任務是季內至季節預報及長期預報，未來 1 年預計發展第 3 週至 6 週及第 1 個月至 6 個月的無縫隙氣候預測，未來 5 年則將進一步發展極端事件預測。採取的策略除改進氣候模式、發展以使用者為導向的氣候預測技術外，同時也將發展 AI 客觀預測技術。

圖 8、「短期氣候預報的現況與未來展望」議題討論，右二為 APCC 預報研究組長 Ms. Soo-Jin Sohn。

下午討論主題為「從氣候預報邁向氣候服務」(圖 9)，首先由本局洪景山主任進行報告，簡報資料如附錄 3。APCC 則由 Dr. JinHo Yoo 介紹 APCC 季內至季節尺度的氣候服務，重點摘錄如下：

1. 對決策有幫助的氣候資訊需具備的特質包括可信度（預報準確度）、重要性（符合使用者需求）、合法性（公開客觀），需要由資訊產製者及使用者共同產出。為確認氣候資訊的可信度，首先必須先評估多模式系集預報隨時間是否有改進，之後再將模式預報資料透過統計降尺度、衝擊模擬等方式轉換為使用者感興趣的預報資訊，例如提供印尼及馬來西亞野火早期預警，以及與日本農業食品產業技術綜合研究機構（National Agriculture and Food Research Organization，NARO）合作進行全球作物玉米產量預測實驗。

2. APCC 對太平洋島國的氣候服務，包括 PICASO（Pacific Island Countries Advanced Seasonal Outlook）及 OSCAR（tailOred System of Climate services for AgRiculture）。APCC 發展 CLIKⓅ（Climate information toolkit for Pacific Islands）網頁工具，預報範圍涵蓋 14 個太平洋島國，這些島國只要有網路就可以利用此工具產製 PICASO 季節預報展望，另外也特別為萬那杜提供 OSCAR 農業決策支援服務，包括農業氣象服務、農事決策支援、作物氣候日誌及農業氣象簡報。

3. 氣候服務的挑戰包括使用者不喜歡機率預報產品、未具備足夠知識以至於不知道如何使用產品、產品內容未能完全符合需求（例如：空間尺度太大、需要季內尺度預報）……等，要克服這些困難，需要多方協力合作，由全球或區域中心產出即時預報，研究機構提出從天氣至季節的無縫隙預報服務示範案例，APCC 或哥白尼氣候變遷服務（Copernicus Climate Change Service，C3S）等單位建立使用者溝通平臺機制，其中特別需要強化國家氣象局的能力，氣候服務才能永續發展。Dr. JinHo Yoo 建議的氣候服務治理架構如圖 10 所示。

4. 至於 APCC 和 KMA 的分工，Dr. JinHo Yoo 提到 APCC 透過研究發展支援 KMA 大部分的氣候預報，在氣候服務方面，KMA 負責韓國國內從民眾到政府的服務，APCC 則負責對外國際服務。為了增強「氣候服務」，建立專門的服務單位可能是比較好的選擇，專責單位可以居間溝通協調，進一步促成公私協力夥伴關係（Public-

Private Partnership）。

圖 9、「從氣候預報邁向氣候服務」議題討論。

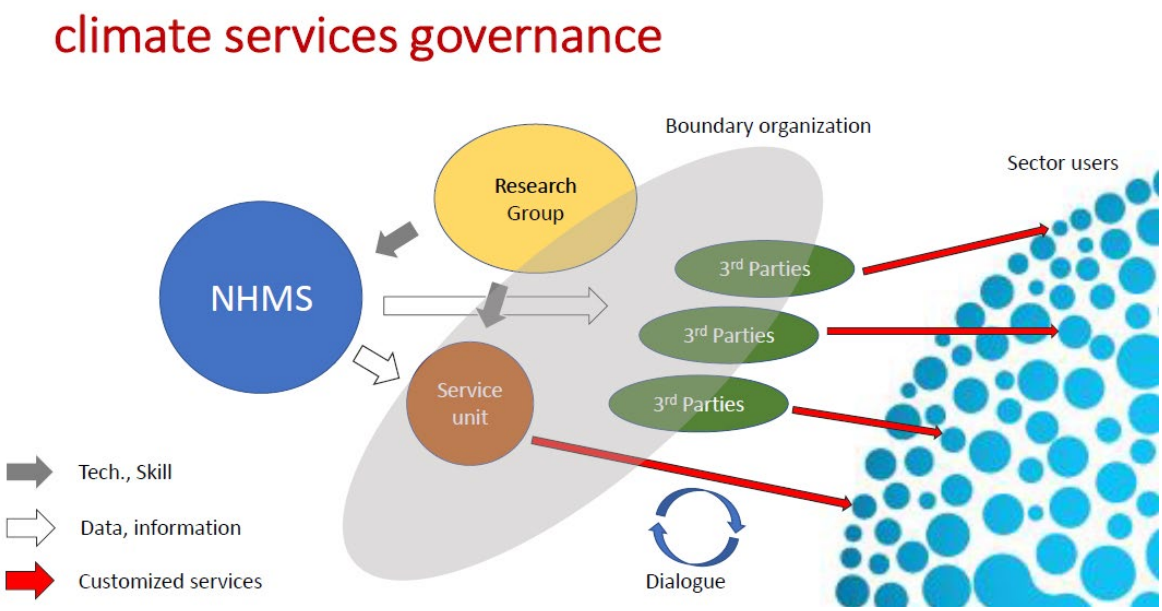


圖 10、氣候服務治理需要多方協力合作，其中國家氣象局扮演著關鍵角色。

三、心得與建議

此次出國期間參加「2023 APCS and APCSW Joint Conference 籌備會議」，除了和 APCC 具體討論共同舉辦 APCS/APCSW 研討會的相關細節之外，同時與亞太經合會氣候中心專家學者進行交流討論，獲益良多。總結來說，本次參訪更進一步瞭解 APCC 在韓國氣象界扮演的角色，大致如下：

(一)、APCC 提供為模式共同發展的氣候測試平臺（Test Bed），協助 KMA/NIMS 加速研發至作業轉移的過程。簡單來說，KMA 為了發布可靠的長期預報，請韓國大專院校進行機制研究、發展預報指引及模式開發，利用 APCC 建立的系統性診斷標準來評估模式技術，預報能力較好的模式再移轉給 NIMS 進行上線作業，以提供 KMA 氣候科學局（Climate Science Bureau，CSB）下的氣候預報組（Climate Prediction Division，CPD）進行長期預報作業。APCC 和 KMA/NIMS 雖然同樣肩負研發任務，但 APCC 負責的預報時間尺度為未來第 2 週至第 6 個月，NIMS 負責的預報時間尺度為未來 12 個月至 10 年以上，因此有關氣候變遷尺度的聯合國世界氣候研究（World Climate Research Programme，WCRP）東亞區域降尺度計畫（Coordinated Regional Climate Downscaling Experiment，CORDEX-EA）即由 NIMS 負責。

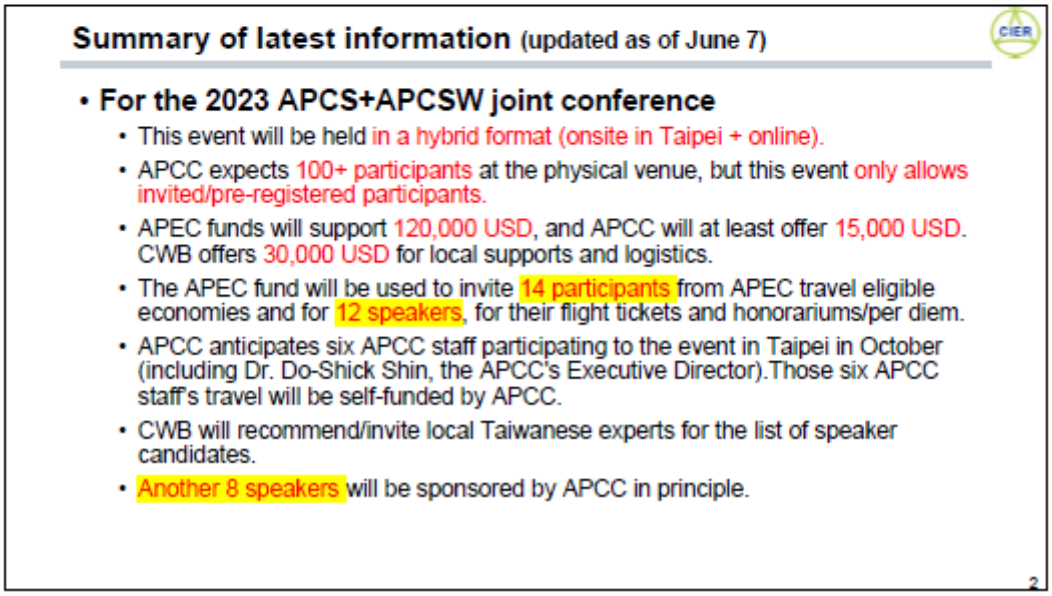
(二)、APCC 同時也進行長期預報技術的研發，以支援 KMA/CSB/CPD 的長期預報作業。目前 APCC 的多模式系集技術只應用於未來 6 個月預報，APCC 預計於今(2023) 年 8 月下旬舉辦的模式提供者會議上討論多模式系集季內預報的可能性，希望各模式作業單位能提供季內預報資料，期待 3 年後可以提供季內即時預報，時程規劃為第 1 年（今年）進行溝通討論尋求共識，第 2 年收集資料並建立預報作業架構，第 3 年進行預報評估，期待第 4 年可以正式發布季內預報。除此之外，APCC 也進行極端氣候的監測預報分析，並嘗試將 AI 技術應用在未來第 3 週至 4 週預報。

(三)、APCC 負責韓國對外的國際服務，除協助 KMA 維運 WMO LC-LRFMME，同時亦為 WWRP/WCRP S2S 計畫國際協調辦公室，提供 APEC 會員經濟體多模式系集氣候預報，亦在綠色氣候基金的支持下進行對太平洋島國及萬那杜的氣候服務。Dr. JinHo Yoo 以自身經驗，建議氣候服務一定要多方協力合作，由學研機構開發預報指引做為國家氣象局發布預報參考，國家氣象局再提供預報資料和資訊給服務專責單位，透過服務專責單位或是第三方與各領域使用者持續溝通對話，進而提供符合使用者需求的客製化服務。

過去本局和 APCC 之間的交流多為參與模式提供者會議、氣候論壇暨工作小組會議，以及共同舉辦國際研討會，本次出訪除對「2023 APCS and APCSW Joint Conference」會議籌備細節取得共識外，更進一步了解 APCC 在韓國氣象界所扮演的角色與定位。建議本局未來可透過下列作為，深化與 APCC 之間的合作：

- 持續精進本局氣候模式技術發展，提供資料參與 APCC 季內至季節多模式系集及 BSISO 預報。
- 持續參與氣候論壇暨工作小組會議及模式提供者會議，以提高國際能見度。
- 若有需要的話，可利用 APCC 提供的系統工具落實對我國南太平洋友邦的氣候服務，本局亦建議 APCC 可利用本局開發的颱風展期預報系統（https://tctracker.cwb.gov.tw/）對 APEC 會員經濟體提供颱風早期預警資訊。
- 建構本局人員氣候預報科研能力，未來可與 APCC 共同舉辦氣候預報研討會（Climate Prediction Workshop），除可促進雙方人員進行交流合作，亦助益精進本局同仁之氣候科研知能。

附錄 1：本局與 APCC 針對「2023 APCS and APCSW Joint Conference」研議的重點摘要



Summary of Concept Note *(check the new outline provided by Suhee on 6/5)*

■ Theme : **Enhancing Energy Security in a Changing Climate for a Resilient Future**

■ Outline :

- ***Keynotes:*** Challenges and opportunities of climate service to promote the energy transition for 2050 net-zero target
- ***Session I:*** Enhancing energy security using climate information
- ***Session II:*** Renewable and clean energy to adapt climate change
- ***Session III:*** Best Practices or Policy Efforts to Enhance Energy Security
- ***Panel Discussion:*** Policy Recommendations and Discussion on Energy System Tran sition and Energy Security in the Context of Climate Change Adaptation – What is our Challenges and Opportunities

3

2023 APEC Climate Symposium(APCS) and Asia Pacific Climate Services Workshop Joint Conference

Theme: Enhancing Energy Security in a Changing Climate for a Resilient Future
Date : October 17-20, 2023
Venue: International Conference Hall, Central Weather Administration, Taipei

Time	10/17(Tue)	10/18(Wed)	10/19(Thu)	10/20(Fri)
AM	**Working Group Meeting** 9:00-11:00	**Opening** 09:00-10:10 **Keynote Speech** (two speakers, 45 min each) 10:30-12:00	**Session III** 10:00-12:00 (4 speakers, 25 min each + session Q&A and wrap-up)	**Field study (Visit 2023 TWCAE event)** 09:00-11:00
PM	**Mr. Shin leads APCC delegation to visit CWA** (60-min CWA tour + 30-min meeting w/ CWA Administrator)	**Session I** 13:00-15:00 (4 speakers, 25 min each + session Q&A and wrap-up) **Session II** 15:30-17:30 (4 speakers, 25 min each + session Q&A and wrap-up) **Event Dinner Banquet**	**Panel Discussion** Moderator: Camyale Chao 13:00-15:00 (5-6 panelists)	**Farewell Lunch**
	VIP Dinner **(5 APCC delegates)** 18:00-20:00		**Closing Remarks** Mr. Shin & Mr. Mark Cheng 15:00-15:15	

4

Host Organizations

APEC Climate Center
- Established in Korea in 2005.
- Strengthening scientific and technological cooperation across the APEC region in order to help economies and societies deal effectively with the consequences of current and future climate-related hazards through the provision of climate information, research and technical support.

Central Weather Bureau
- The central government meteorological research and forecasting institution of Taiwan.
- Making astronomical observations, reporting on sea conditions, and providing earthquake reports.

Chung-Hua Institution for Economic Research
- A Taiwan-based international economic policy think tank established in 1981.
- In the last decade, CSTPE team of CIER has worked together with CWB for the users' assessment and economic evaluation for climate services in Taiwan.
- Co-hosting many international/domestic events/conferences with CWB since 2019.

International Climate Development Institute
- A non-profit organization which concerns the right of development under climate change impacts.
- Providing professional knowledge and skills on climate governance, this think tank engages in planning and implementing of national climate policy with the public-private partnership approach. Supporting local communities and vulnerable groups on capacity building to achieve climate-resilient and sustainable lives.

Taiwan Climate Services Partnership
- A non-profit organization established in Taiwan in 2021.
- Focus on climate service development, link the suppliers with potential domestic demand users in the Value Chain of climate services to strengthen collaboration between public and private sectors.

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Conference Organizing Committee Members

APEC Climate Center (APCC)	**Dr. Kyung-Won Park**, Research Fellow, Prediction Research Department **Ms. Sangwon Moon**, Head, External Affairs Department **Ms. Suhee Han**, Project Manager, External Affairs Department **Ms. Yeuteum Na**, Project Manager, External Affairs Department
Central Weather Bureau (CWB)	**Dr. Jing-Shan Hong**, Director, R&D Center **Ms. Meng-Shih Chen**, Senior Technical Specialist, R&D Center **Dr. Wei-Peng Huang**, Section Chief, R&D Center **Mr. Yao-Te Tsai**, Technical Specialist, Sectarian Office
Chung-Hua Institution for Economic Research (CIER)	**Dr. Hen-I Lin**, Director, CSTPE Center **Dr. Jen-Hong Hsu**, Research Analyst, CSTPE Center **Dr. Yu-Chieh Chang**, Assistant Research Scientist, CSTPE Center **Ms.Yu-Ling Chu**, Assistant Associate, CSTPE Center
International Climate Development Institute (ICDI)	**Mr. Kung-Yueh Camyale Chao**, Executive Director

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Guest List: APCC and WXBC

APEC Climate Center (APCC)	**Dr. DoShick Shin** (Executive Director) **Dr. Jinyoung Rhee** (Director, Climate Services and Research Division) **Dr. Kyung-Won Park** (Research Fellow, Prediction Research Department) **Ms. Sangwon Moon** (Head, External Affairs Department) **Ms. Suhee Han** (Project Manager, External Affairs Department) **Ms. Yeuteum Na** (Project Manager, External Affairs Department)
Weather Business Consortium (WXBC)	**Dr. Noboru Koshizuka** (President of WXBC, Professor of The University of Tokyo) **Dr. Takashi Michikata** (*Associate Professor*, The University of Tokyo) One more expert will be recommended later

*WXBC delegation was invited by TCSP(Taiwan Climate Services Partnership) in February to participate in the 2023 APCSW.
**WXBC website, https://www.wxbc.jp/

7

Accommodation

HOTEL	Room Rate (tax included)	Star Rating	Distance to CWB (km)		Google Reviews	Address
台北福華大飯店*** The Howard Plaza Hotel-Taipei	~143 USD (4,400 TWD)	★★★★★	3.5	12-minute drive	4.2	No. 160, Sec. 3 , Jen Ai Road, Taipei 10657

*This hotel is affiliated with CIER, and offers its contracted price for this event.

**CIER has reserved 40 single-bed rooms at the Howard Plaza Hotel (4 nights, 10/17-21), and 10 single-bed rooms (10/16-17). If the rooms are not enough, we will provide the second hotel option near the Howard Plaza Hotel.

*Since there is a limit of USD$137 per night for APCC fund(6+8, max 14 people), CWB will cover the difference of hotel rate.

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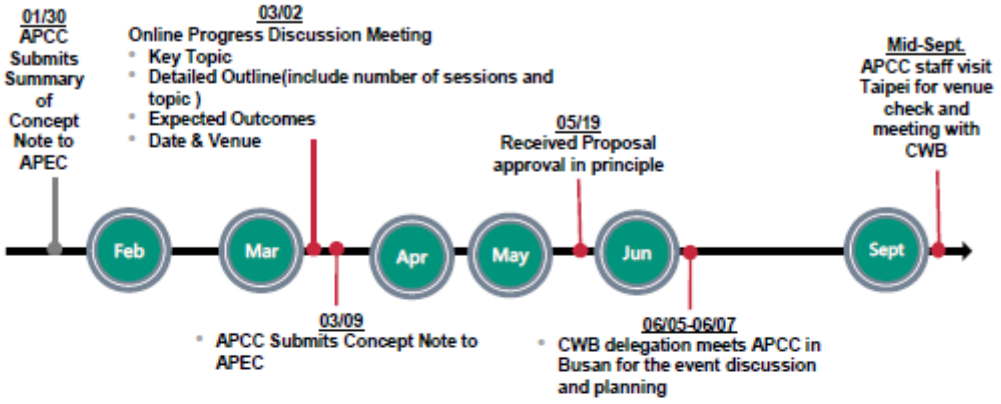
Timeline for the 2023 APCS+APCWS event planning



9

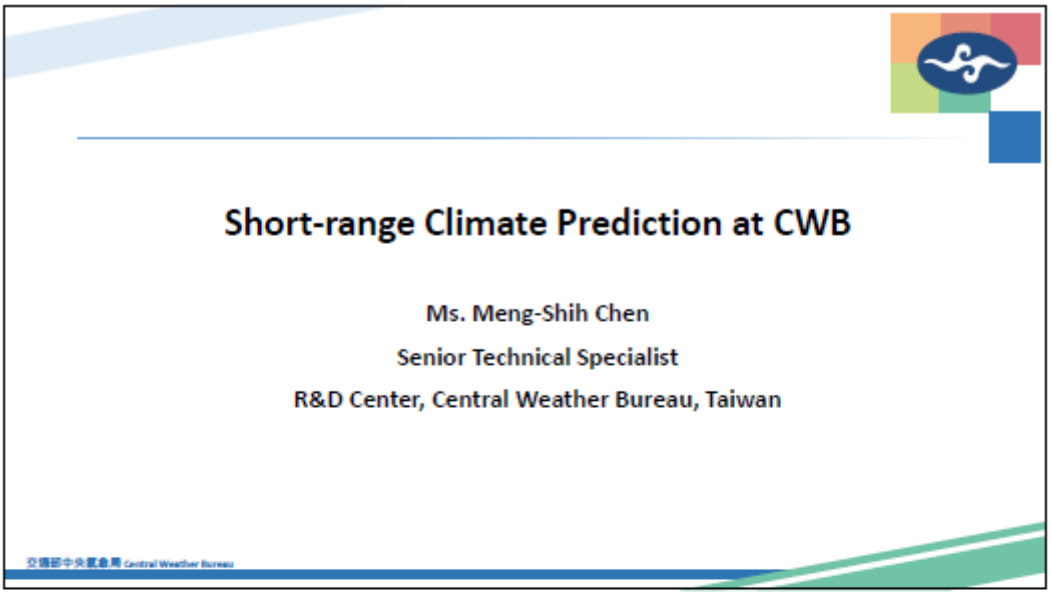
Discussion Outlines

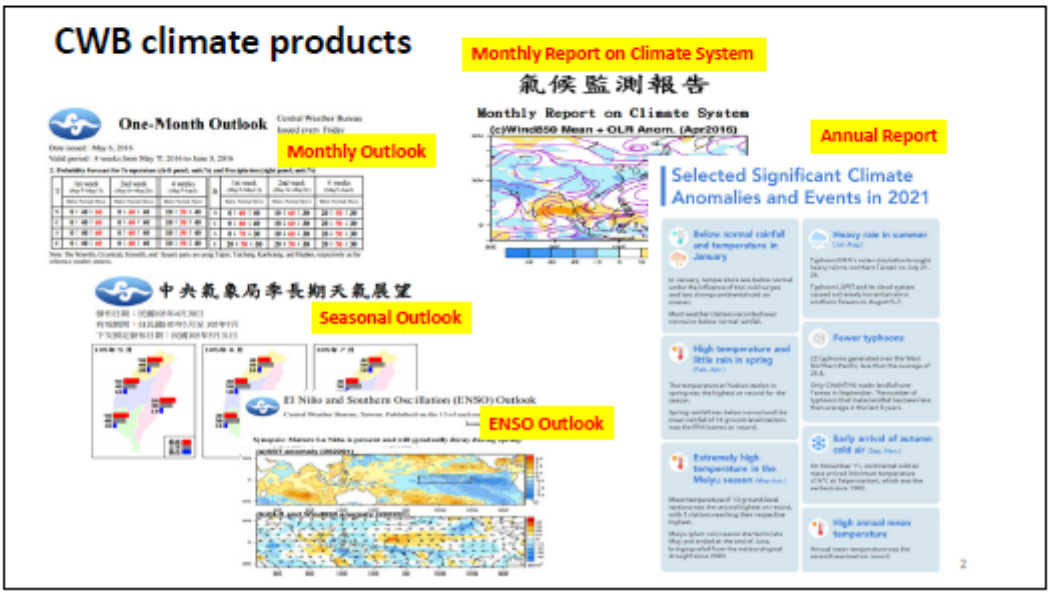
- **Logistics and local supports (CWB+CIER)**
- **Budget planning (CWB+APCC)**
- **Preliminary plan/list for speaker candidates (CWB+APCC+ICDI)**

  2 keynote speakers and 18 expert speakers/panelists
- **Moderators (CWB/APCC/Invited Experts)**
- **Important check-points for the next three months**

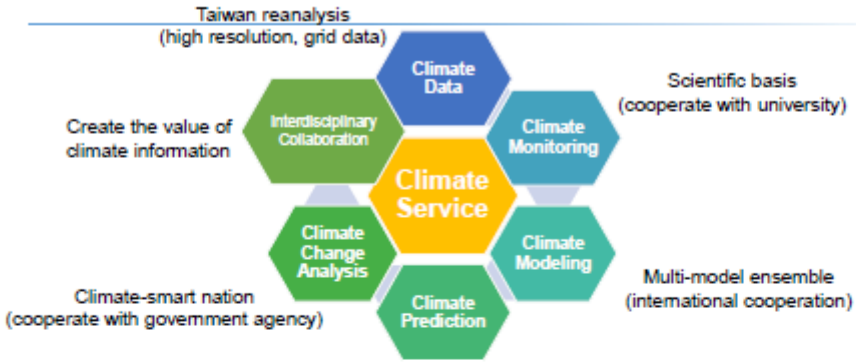
10

附錄 2、本局短期氣候預報簡報摘錄





Climate Service in CWB

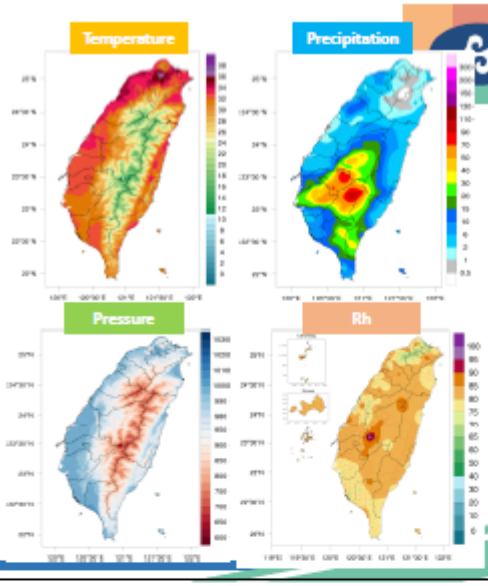


CWB's weather station

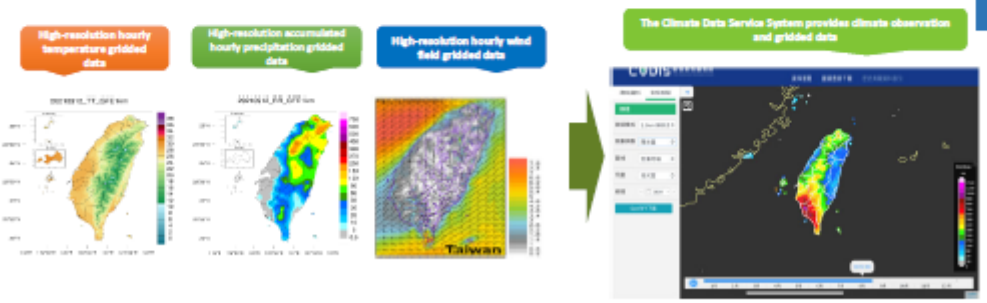
- Manual station 27
- Observational operation follows surface observation guidebook of CWB
  - based on Guide to Meteorological Instruments and Methods of Observation, WMO 1996
  - The guidance include observer, observed elements, observing times etc.
- AWS about 500 stations

Gridded Climate Dataset

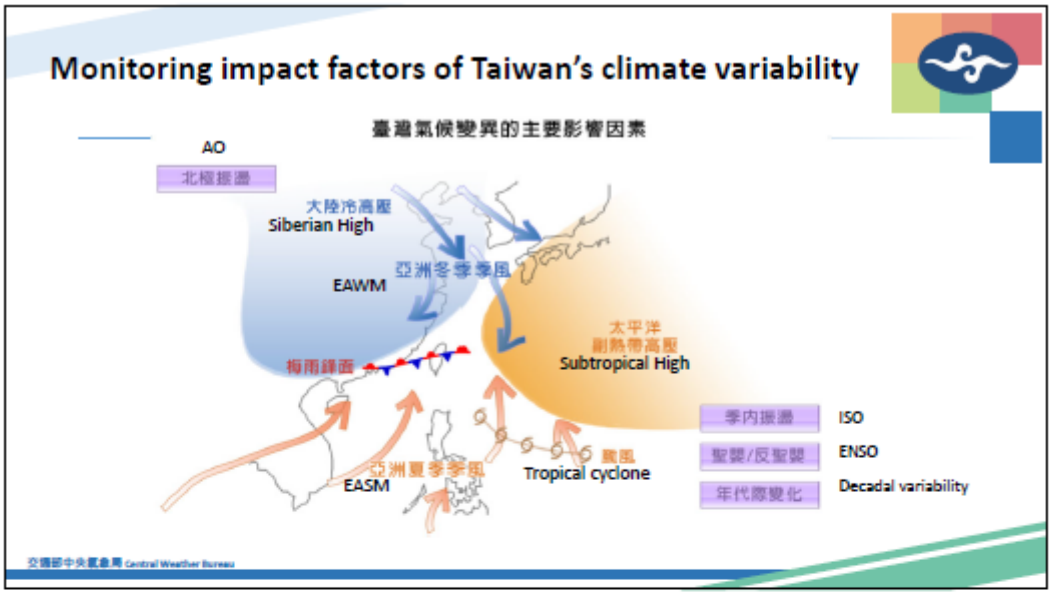
- Temperature：1998~last year
  - UK (Universal Kriging)
- Precipitation：1998~last year
  - SK (Simple Kriging)
- Pressure：2003~last year
  - UK (Universal Kriging)
- Relative Humidity：2012~last year
  - OK (Simple Kriging)
- Dew point temperature：2012~last year
  - Derived from temperature and relative humidity.

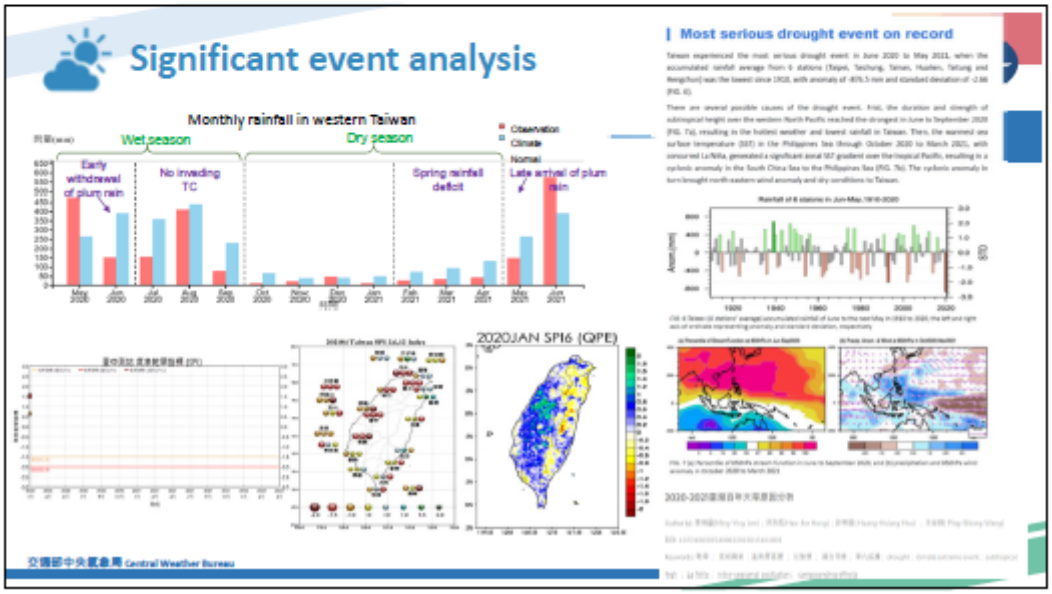


Gridded Climate Dataset Service



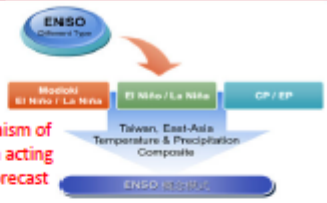
We will establish climate data validation techniques to improve the quality and reliability of climate data. We will produce a Taiwan high-resolution 1-km climate gridded dataset that includes temperature, pressure, and accumulated precipitation at hourly, daily, and monthly time scales. This will enhance the precision of the climate gridded data and provide government agencies, disaster prevention organizations, and academic research.


Monitoring impact factors of Taiwan's climate variability
臺灣氣候變異的主要影響因素
AO
北極振盪
大陸冷高壓
Siberian High
亞洲冬季季風
EAWM
梅雨鋒面
太平洋
副熱帶高壓
Subtropical High
季內振盪
ISO
聖嬰/反聖嬰
ENSO
年代際變化
Decadal variability
颱風
Tropical cyclone
亞洲夏季季風
EASM
交通部中央氣象局 Central Weather Bureau

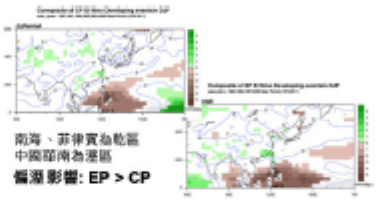

Significant event analysis
Monthly rainfall in western Taiwan
Wet season
Dry season
Observation
Climate Normal
Early withdrawal of plum rain
No invading TC
Spring rainfall deficit
Late arrival of plum rain
2020JAN SPI6 (QPE)
Most serious drought event on record
交通部中央氣象局 Central Weather Bureau

Monitoring Current Status of Climate

Impacts of major climate phenomenon



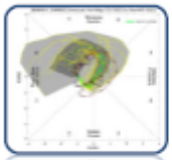
Understand the mechanism of large- scale phenomena acting on Taiwan to develop forecast guidance



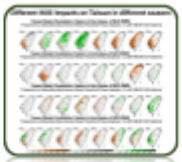
南海、菲律賓為乾區
中國華南為濕區
偏濕影響: EP > CP

MJO

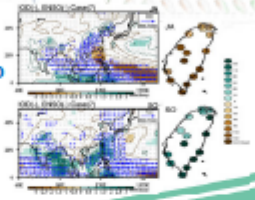
Monitoring & Forecasts



Composites



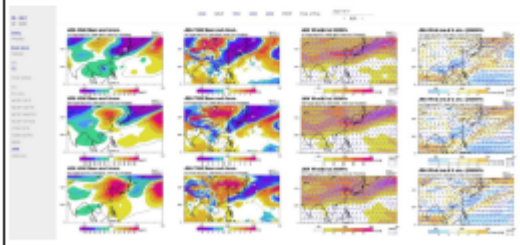
IOD & ENSO composite



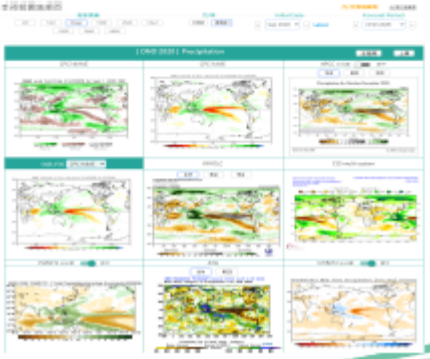
Models for short-range Climate Prediction

Forecast Decision support system

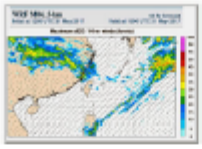
Weekly (SubX, EC, GEFS, JMA, CWB)



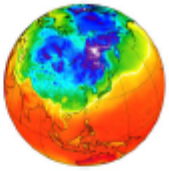
Monthly and Seasonal
(NMME, IMME, APCC, WMOLC, C3S, CWB, JMA)



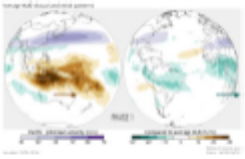
NWP systems at CWB



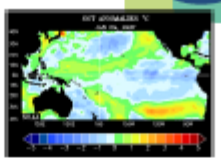
Regional weather
- CWB WRFD (5 days)
- CWB TWRF
- CWB WEPS
- CWB RWRF (13 hours)
- CWB CEPS



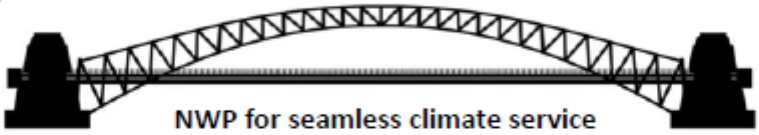
Global weather
- CWBGFS (16 days)
  → CWB FV3GFS
  (operation in this year)



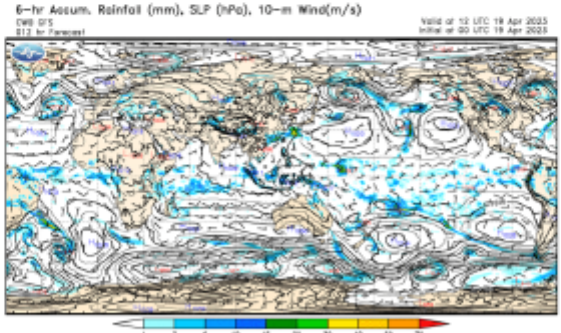
Extended weather (S2S)
- CWB GEPS (45 days)



Short-term climate
- TCWB 1T1.1 (8 months)
  → CWBCFS (global + RSM)



Global model at CWB



CWB's goals to use the FV3GFS:
- Build a flexible global NWP and DA system for both operation and research in Taiwan's community.
- Joint the world-wide UFS community development.

2002	2003	2004	2007	2010	2011	2014	2016	2020	2023
T119L30	SSI 3DVar	T179L30	T239L30	GSI 3DVar	T319L40 (~40 km)	GSI hybrid 3DEnVar	T311L60 (~25 km)	TCo639L72 (~18 km)	FV3 C384L64 (~25 km)

CWB Global Forecast System (CWBGFS) — CWB FV3GFS

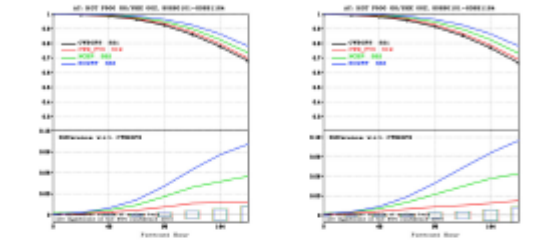
CWB FV3GFS v1 semi-operational test: 2022

500-hPa Height Anomaly Correlation

1 Jan~24 Nov 2022

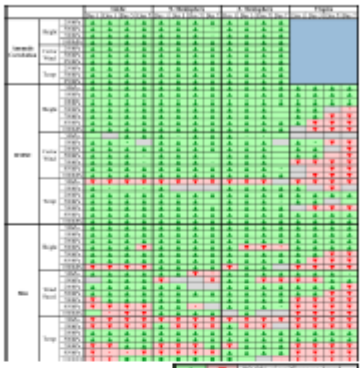
NH (20-80N)

SH (20-80S)



Scorecard – Green/Red :

CWB FV3GFS is Better/Worse than CWBGFS



Verified against NCEP analysis

CWBGFS (OP-TCo639; 18km; DA at 25km with EC bogus data)

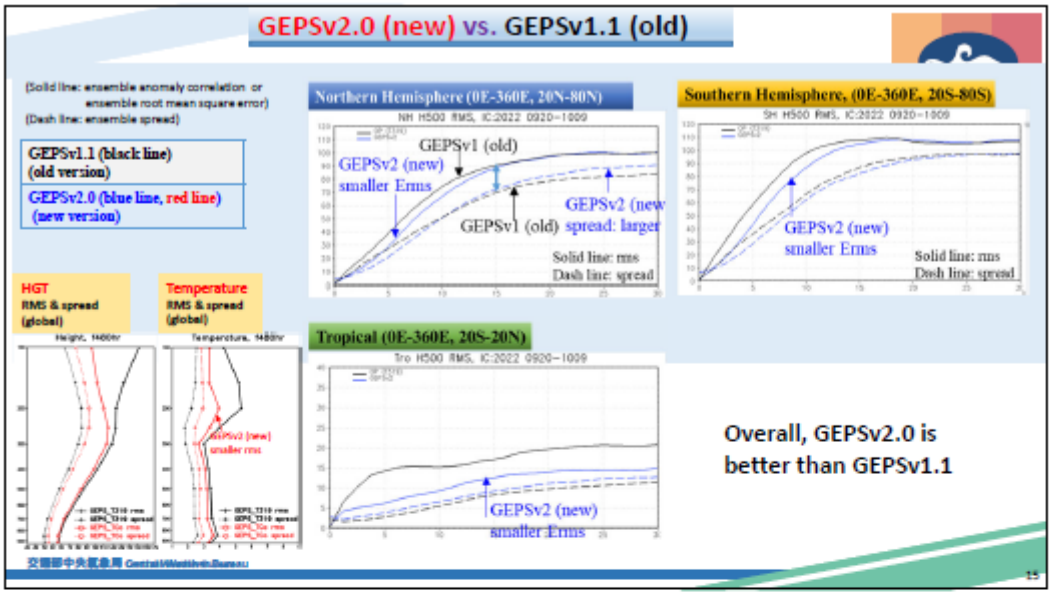
CWB FV3GFS (C384T; 25km)

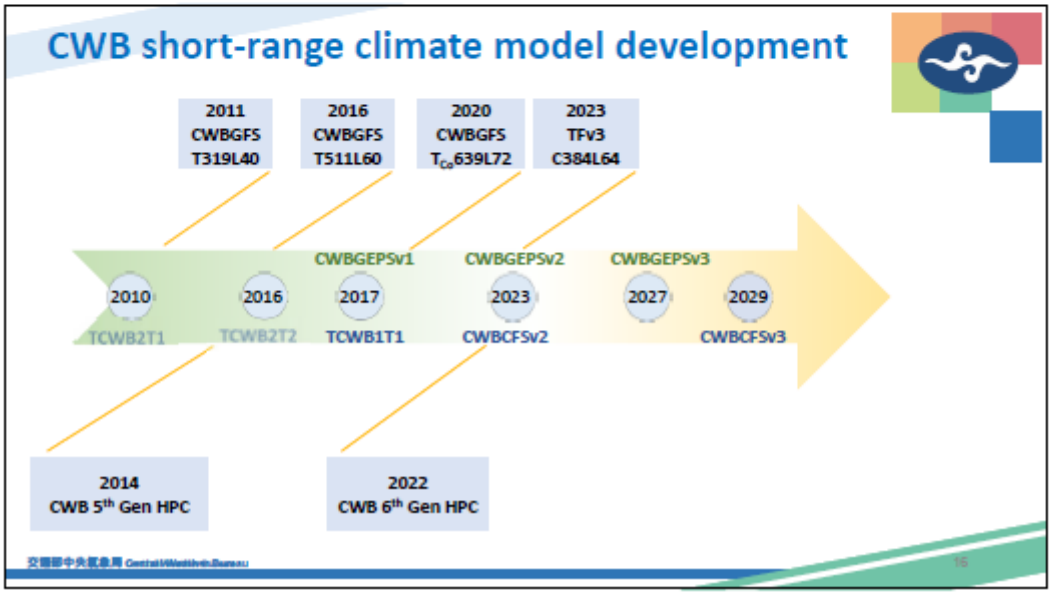
NCEP GFS (C768; 13km)

ECMWF IFS (9km)

Schedule of CWB GEPS development

Model/System	Current version	2023	2024	2025	2026	2027
Atmosphere Global	T319L40 (~45km) Eulerian +Semi implicit	T_{CO}383L72 (~28km) Semi-Lagrangian +Semi implicit				
Atmosphere Regional	N/A		NCEP RSM 5km L72			
Ocean	fixed SST	SIT +MOM3(TCWB1T1)				MOM5 0.25° L40
Sea ice	N/A	climatology				SIS 0.25° L3
wave	N/A			WW3 0.25°		
Initial perturbation & stochastic physics	SV/SPPT	EnKF/SPPT	LETKF/SPPT+SKEB		LETKF /SPPT+SKEB+SSST	
Forecast Ensemble size	21			31		
Re-forecast Ensemble size	N/A	CFSR (2001-2020) Time lag		CFSR(2001-2020) 10 mem.		


GEPSv2.0 (new) vs. GEPSv1.1 (old)
(Solid line: ensemble anomaly correlation or ensemble root mean square error)
(Dash line: ensemble spread)
GEPSv1.1 (black line) (old version)
GEPSv2.0 (blue line, red line) (new version)
Northern Hemisphere (0E-360E, 20N-80N)
GEPSv1 (old)
GEPSv2 (new) smaller Erms
GEPSv2 (new) spread: larger
GEPSv1 (old)
Solid line: rms
Dash line: spread
Southern Hemisphere, (0E-360E, 20S-80S)
GEPSv2 (new) smaller Erms
Solid line: rms
Dash line: spread
HGT RMS & spread (global)
Temperature RMS & spread (global)
Tropical (0E-360E, 20S-20N)
GEPSv2 (new) smaller Erms
Overall, GEPSv2.0 is better than GEPSv1.1


CWB short-range climate model development
2011 CWBGFS T319L40
2016 CWBGFS T511L60
2020 CWBGFS T_{Co}639L72
2023 TFv3 C384L64
CWBGEPSv1
CWBGEPSv2
CWBGEPSv3
2010
2016
2017
2023
2027
2029
TCWB2T1
TCWB2T2
TCWB1T1
CWBCFSv2
CWBCFSv3
2014 CWB 5th Gen HPC
2022 CWB 6th Gen HPC

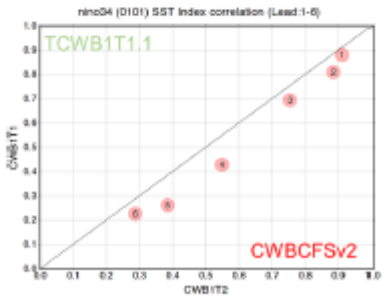
Schedule of CWB CFS development

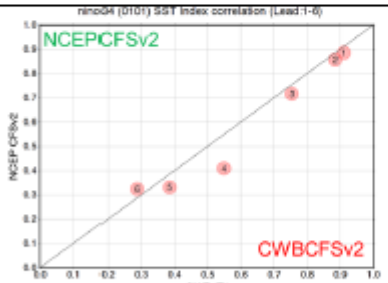
Model/System	Current version	2023	2024	2025	2026	2027	2028	2029
Atmosphere Global	T119L40 (~110km) Eulerian +Semi implicit	T_L359L60 (~55km) Semi-Lagrangian +Semi implicit			T_{co}199L128 (~50km) Semi-Lagrangian +Semi implicit			
Atmosphere Regional	N/A	NCEP RSM 12km L42			NCEP RSM 12km L128			
Ocean	MOM3 1° L40	MOM5 0.5° L40						MOM6 0.25° L75
Sea ice	climatology	SIS 0.5° L3						SIS2 0.25° L5
aerosol	N/A				Gocart			
wave	N/A				WW3 0.5°			
Initial perturbation & stochastic physics	N/A				LETKF /SPPT			LETKF or BVs /SPPT
Forecast Ensemble size	Time lag				10 mem.			6/day +time lag
Re-forecast Ensemble size	CFSR (1991-2020) Time lag				CFSR (1991-2020) 5 mem.			5/day +time lag

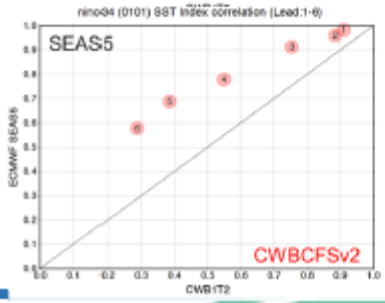
(For Net Zero)

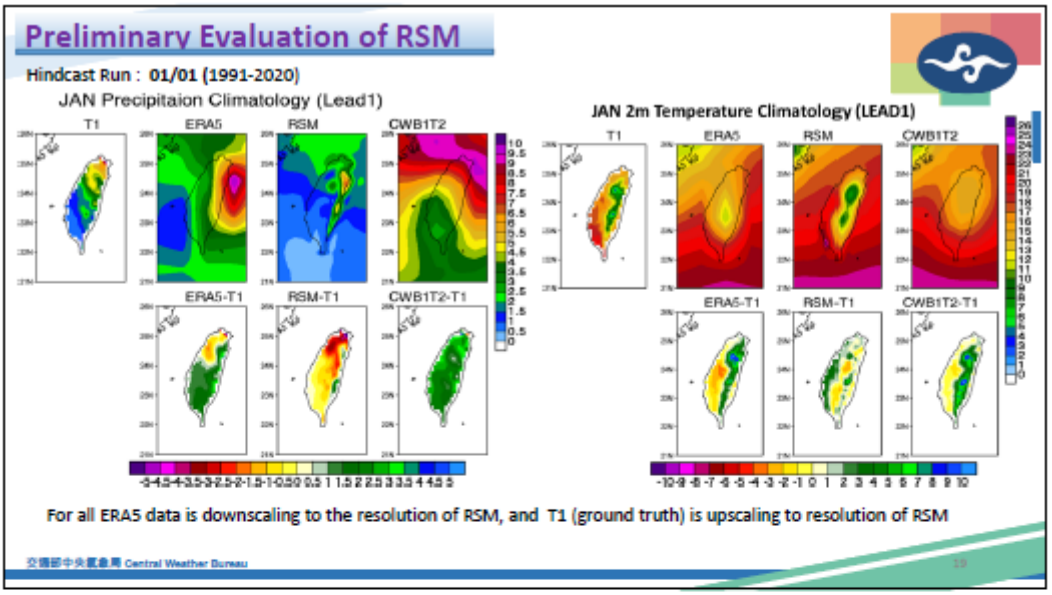
Preliminary Evaluation of CWBCFSv2 (Nino3.4)

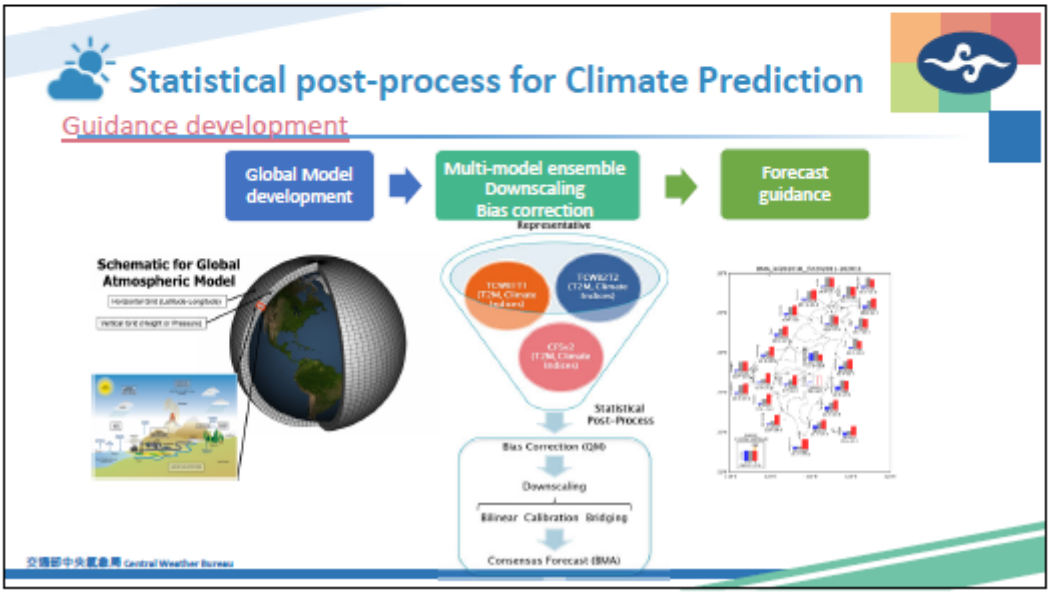
Hindcast Run : 01/01 (1991-2020)

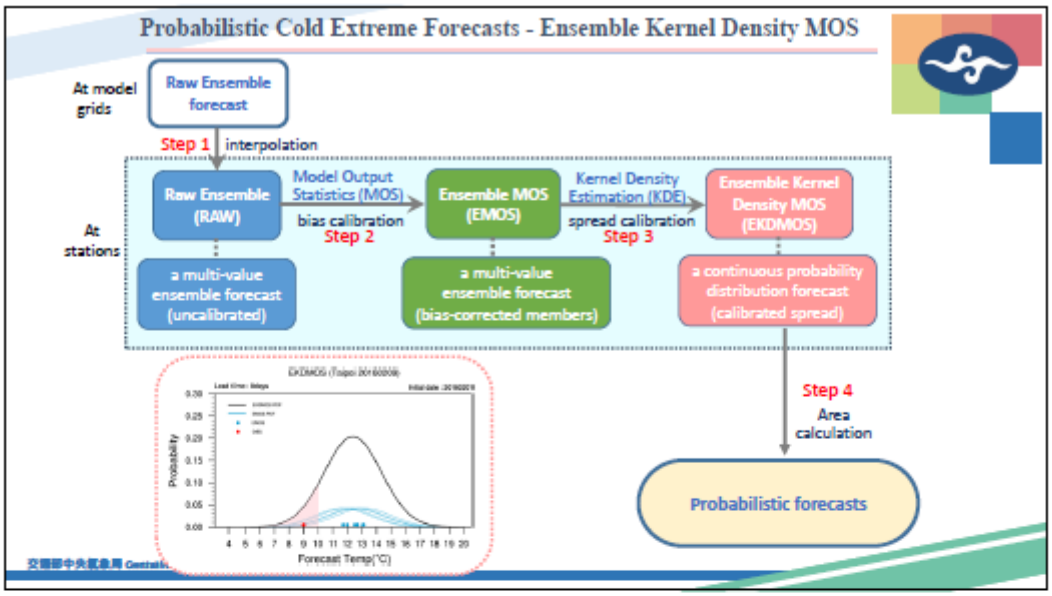


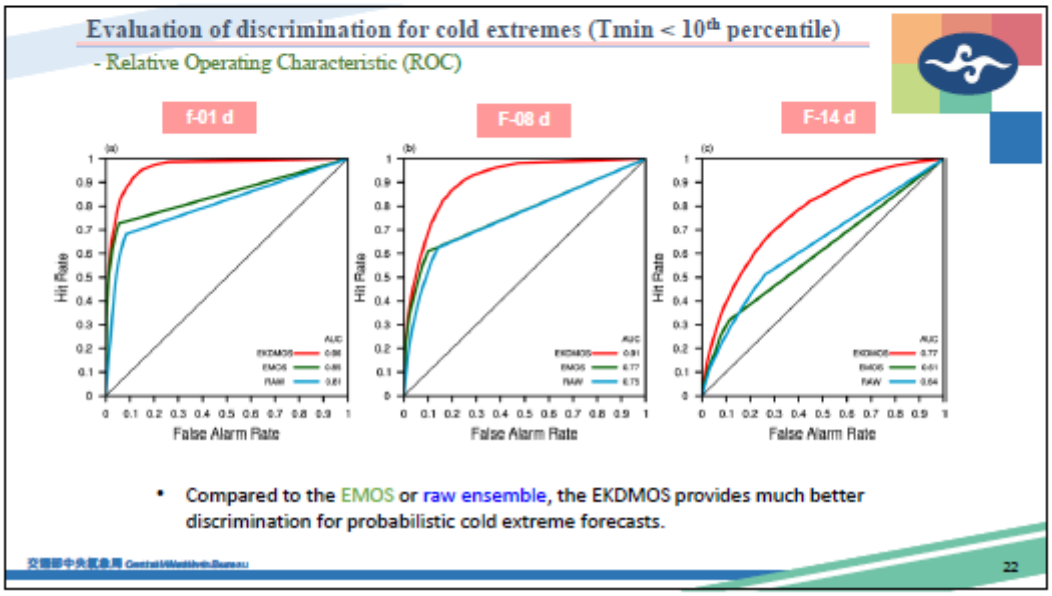


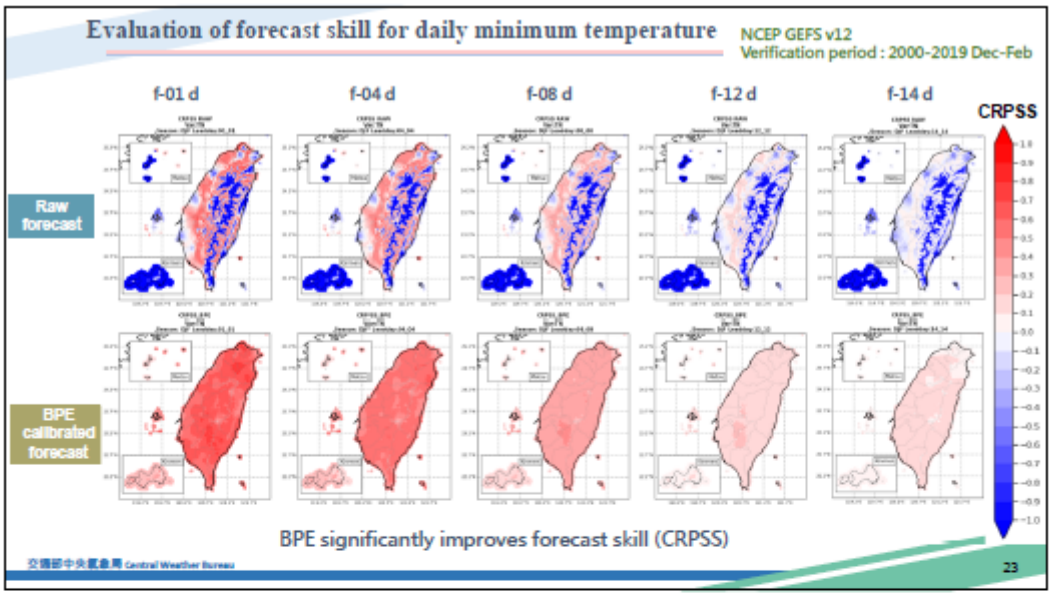


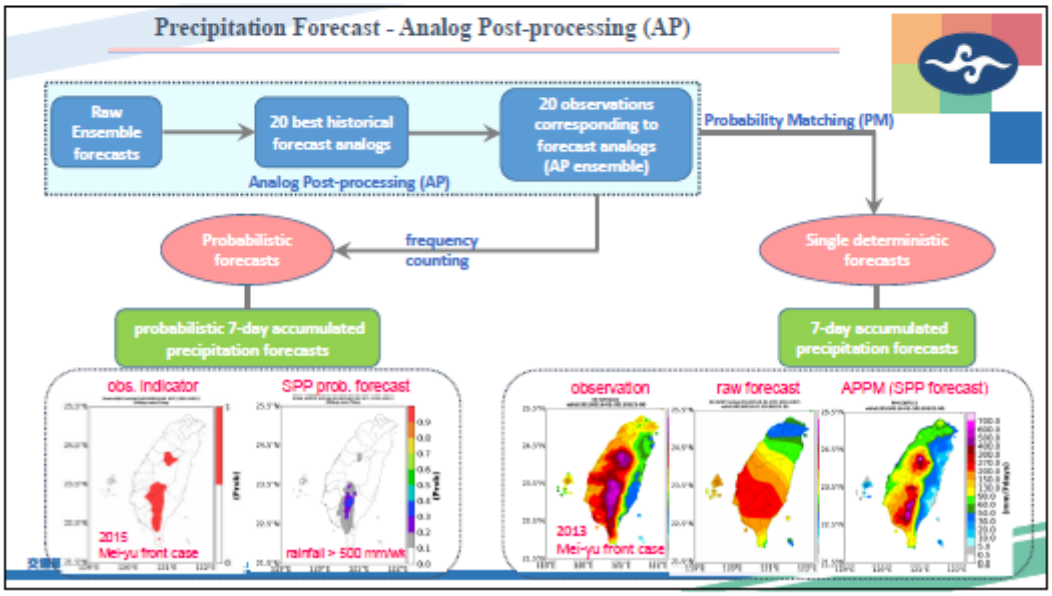

Preliminary Evaluation of RSM
Hindcast Run : 01/01 (1991-2020)
JAN Precipitaion Climatology (Lead1)
T1
ERA5
RSM
CWB1T2
ERA5-T1
RSM-T1
CWB1T2-T1
JAN 2m Temperature Climatology (LEAD1)
T1
ERA5
RSM
CWB1T2
ERA5-T1
RSM-T1
CWB1T2-T1
For all ERA5 data is downscaling to the resolution of RSM, and T1 (ground truth) is upscaling to resolution of RSM
交通部中央氣象局 Central Weather Bureau

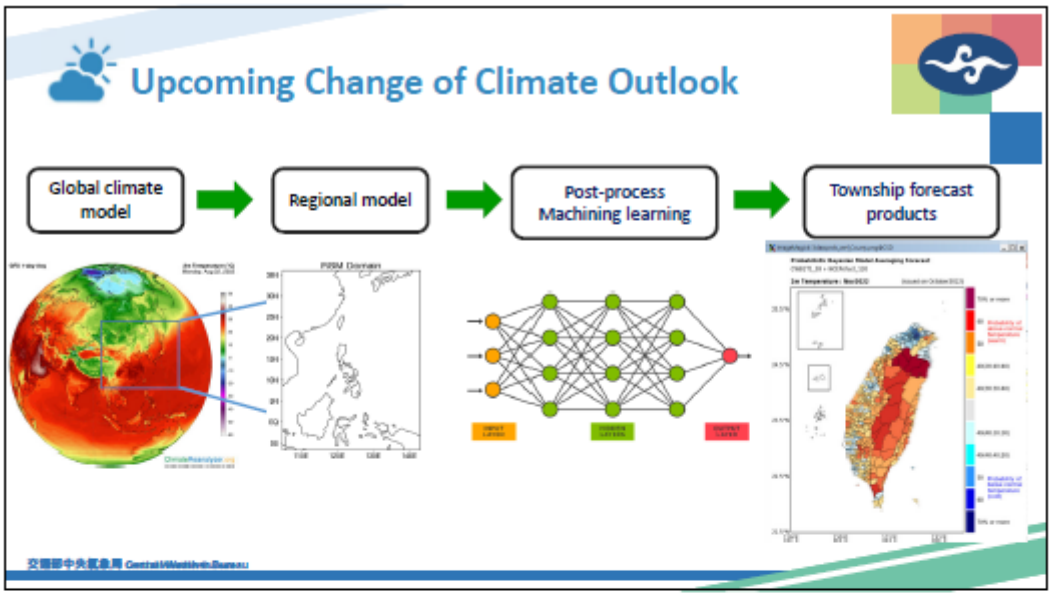

Statistical post-process for Climate Prediction
Guidance development
Global Model development
Multi-model ensemble Downscaling Bias correction
Forecast guidance
Schematic for Global Atmospheric Model
Representative
Statistical Post-Process
Bias Correction (QM)
Downscaling
Bilinear Calibration Bridging
Consensus Forecast (BMA)
交通部中央氣象局 Central Weather Bureau

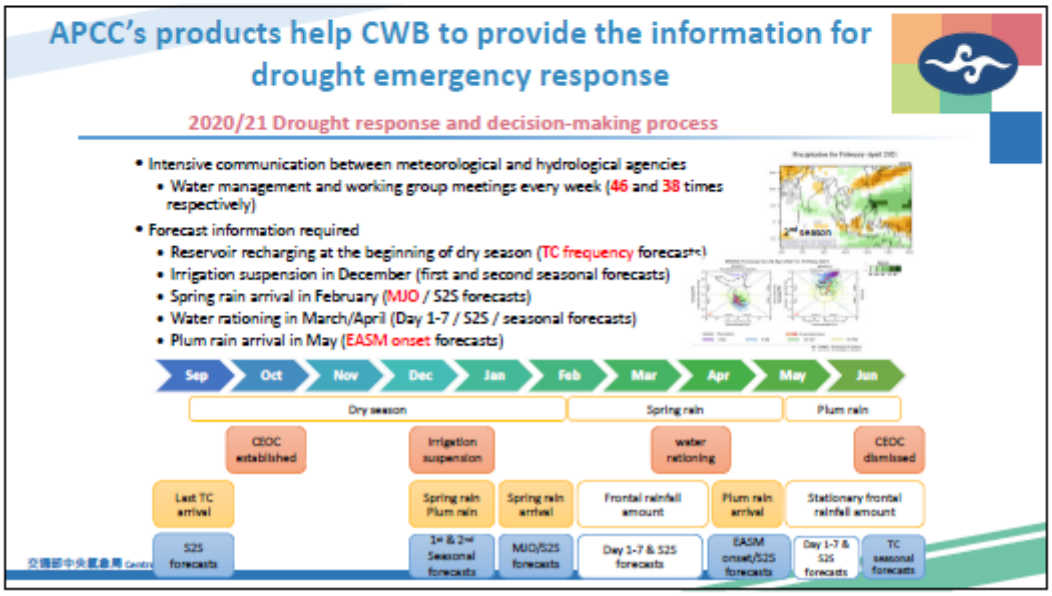

Probabilistic Cold Extreme Forecasts - Ensemble Kernel Density MOS
At model grids
Raw Ensemble forecast
Step 1
interpolation
At stations
Raw Ensemble (RAW)
Model Output Statistics (MOS)
bias calibration
Step 2
Ensemble MOS (EMOS)
Kernel Density Estimation (KDE)
spread calibration
Step 3
Ensemble Kernel Density MOS (EKDMOS)
a multi-value ensemble forecast (uncalibrated)
a multi-value ensemble forecast (bias-corrected members)
a continuous probability distribution forecast (calibrated spread)
Probability
Forecast Temp(°C)
Step 4
Area calculation
Probabilistic forecasts


Evaluation of discrimination for cold extremes (Tmin < 10th percentile)
- Relative Operating Characteristic (ROC)
f-01 d
F-08 d
F-14 d
Hit Rate
False Alarm Rate
• Compared to the EMOS or raw ensemble, the EKDMOS provides much better discrimination for probabilistic cold extreme forecasts.
22


Evaluation of forecast skill for daily minimum temperature
NCEP GEFS v12
Verification period : 2000-2019 Dec-Feb
f-01 d
f-04 d
f-08 d
f-12 d
f-14 d
CRPSS
Raw forecast
BPE calibrated forecast
BPE significantly improves forecast skill (CRPSS)
23

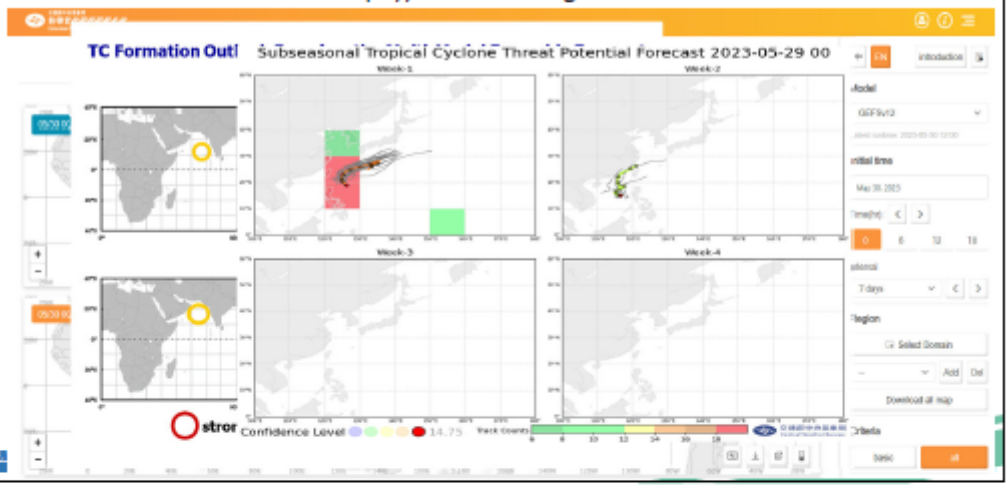

Precipitation Forecast - Analog Post-processing (AP)
Raw Ensemble forecasts
20 best historical forecast analogs
20 observations corresponding to forecast analogs (AP ensemble)
Analog Post-processing (AP)
Probability Matching (PM)
Probabilistic forecasts
frequency counting
Single deterministic forecasts
probabilistic 7-day accumulated precipitation forecasts
7-day accumulated precipitation forecasts
obs. Indicator
SPP prob. forecast
2015 Mei-yu front case
rainfall > 500 mm/wk
observation
raw forecast
APPM (SPP forecast)
2013 Mei-yu front case


Upcoming Change of Climate Outlook
Global climate model
Regional model
Post-process Machining learning
Township forecast products


APCC's products help CWB to provide the information for drought emergency response
2020/21 Drought response and decision-making process
• Intensive communication between meteorological and hydrological agencies
• Water management and working group meetings every week (46 and 38 times respectively)
• Forecast information required
• Reservoir recharging at the beginning of dry season (TC frequency forecasts)
• Irrigation suspension in December (first and second seasonal forecasts)
• Spring rain arrival in February (MJO / S2S forecasts)
• Water rationing in March/April (Day 1-7 / S2S / seasonal forecasts)
• Plum rain arrival in May (EASM onset forecasts)
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Dry season
Spring rain
Plum rain
CEOC established
Irrigation suspension
water rationing
CEOC dismissed
Last TC arrival
Spring rain Plum rain
Spring rain arrival
Frontal rainfall amount
Plum rain arrival
Stationary frontal rainfall amount
S2S forecasts
1st & 2nd Seasonal forecasts
MJO/S2S forecasts
Day 1-7 & S2S forecasts
EASM onset/S2S forecasts
Day 1-7 & S2S forecasts
TC seasonal forecasts

Extreme : extended-range threat potential forecast guidance

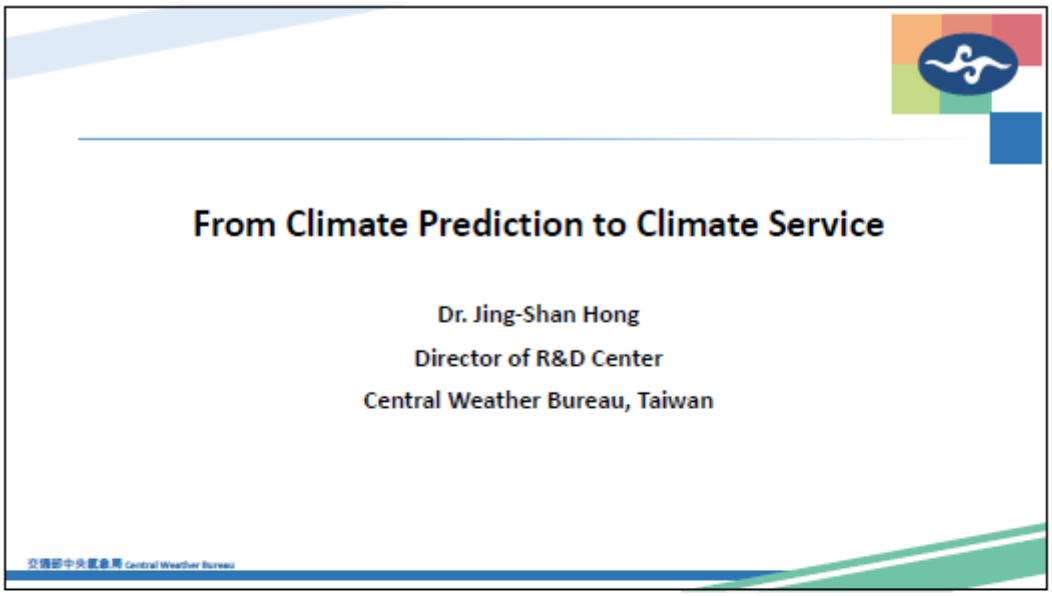
https://tctracker.cwb.gov.tw

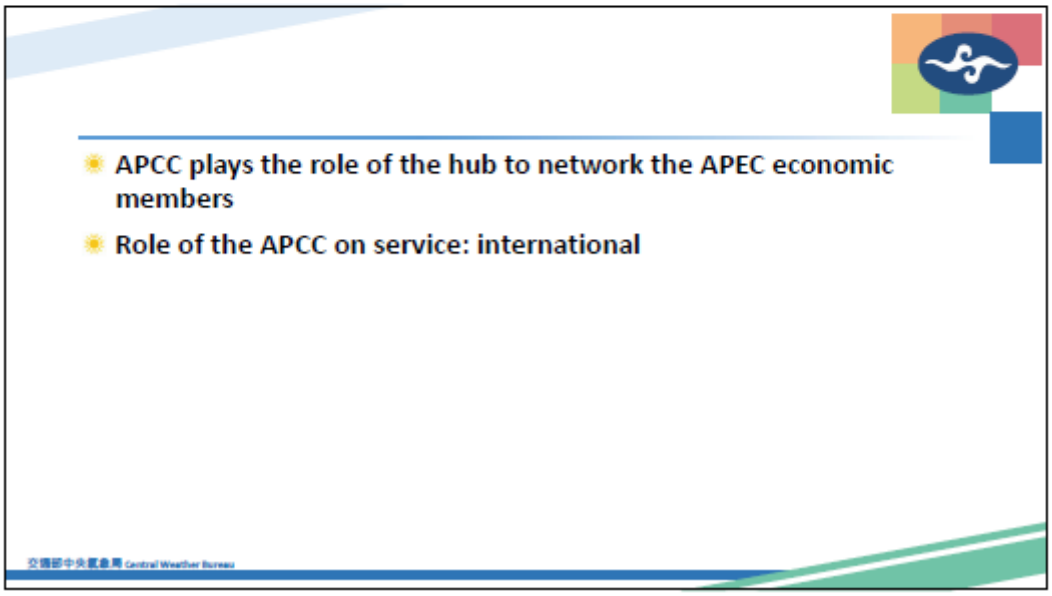


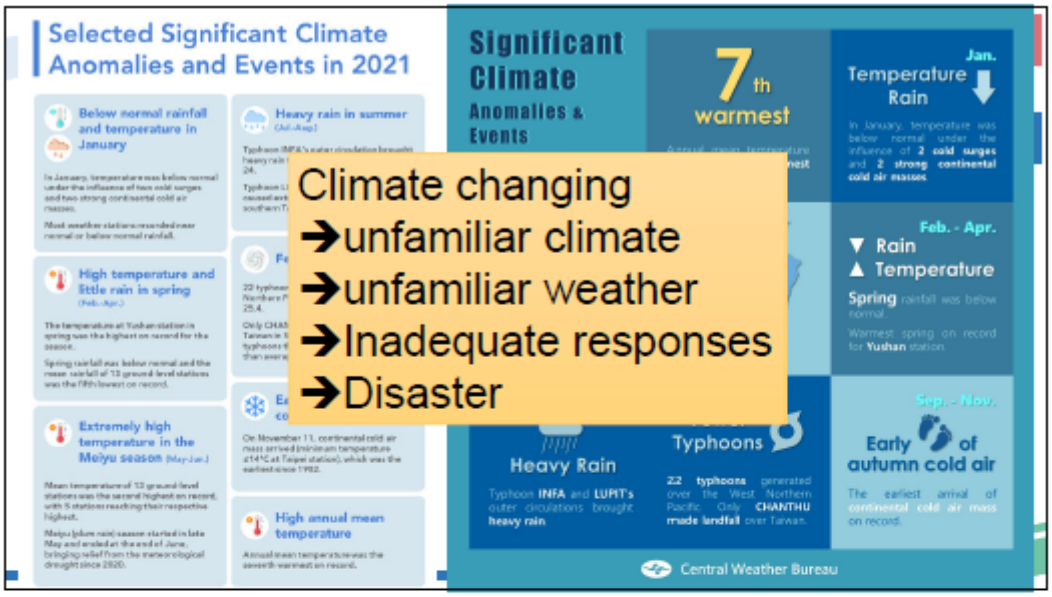
CWB's roadmap

- S2S (Sub-seasonal and seasonal) & ISI (Intra-seasonal and Inter-annual) forecasts
  - 7-day → 14-day; week2 → week3-4; 3-month → 6-month
  - station-based → gridded
  - Mean → Extreme
  - Qualitative → Quantitative
  - Research → Operation
- Provide Service for other governmental agency in climate risk management
  - Building nation's climate resilience under climate change impact
  - ISI (intra-seasonal, seasonal to interannual) → S2S (sub-seasonal to seasonal) → A2D (annual to decadal)

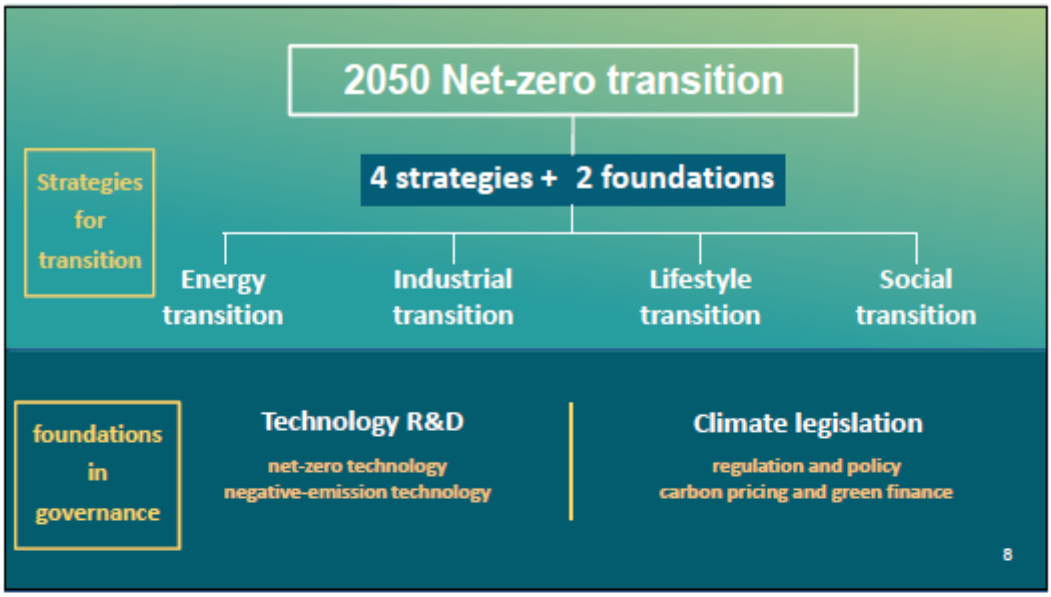
附錄 3、本局氣候服務簡報摘錄

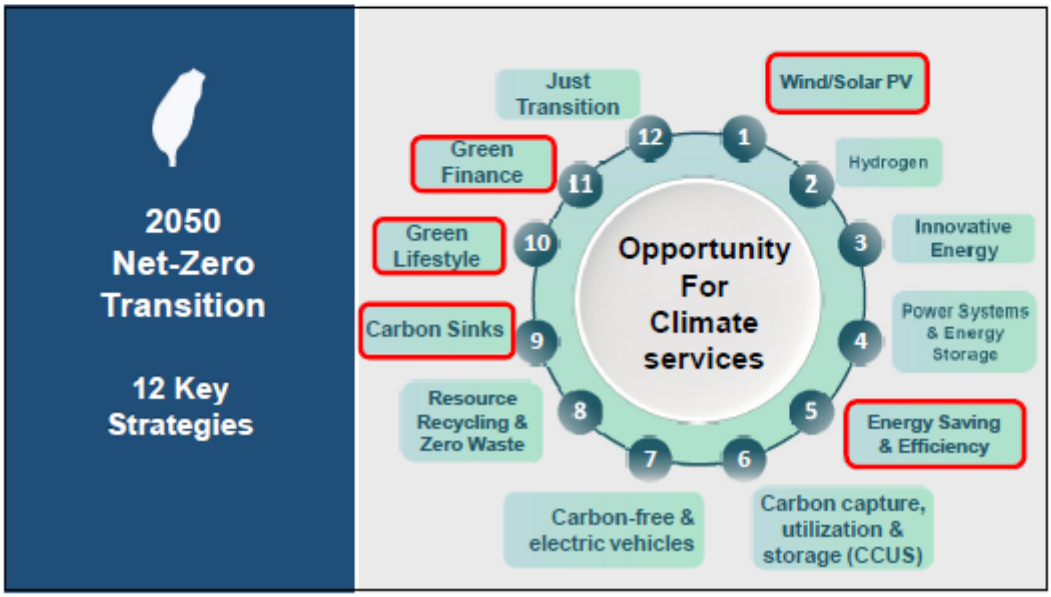


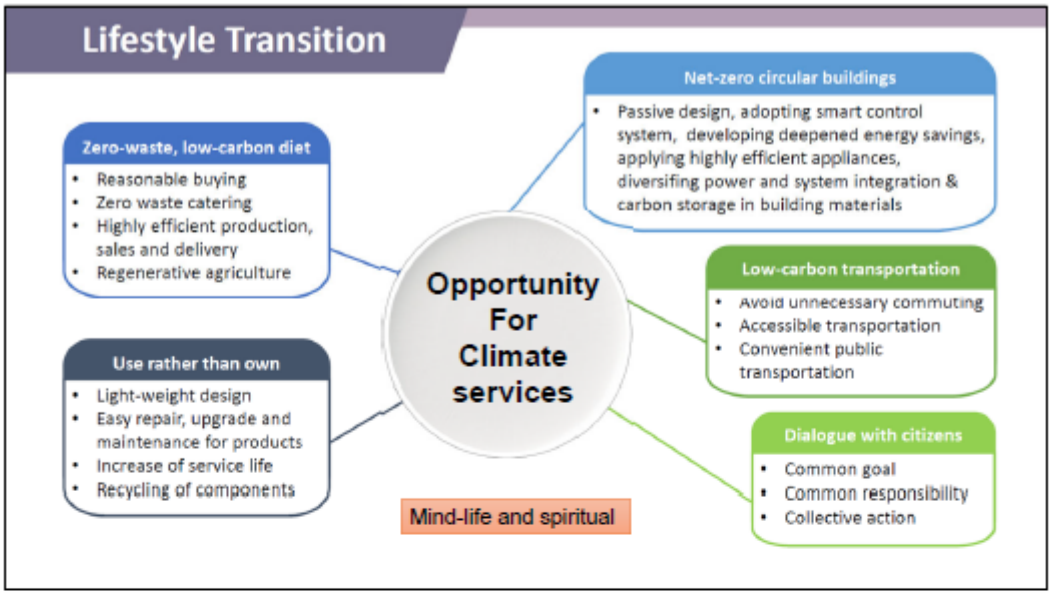


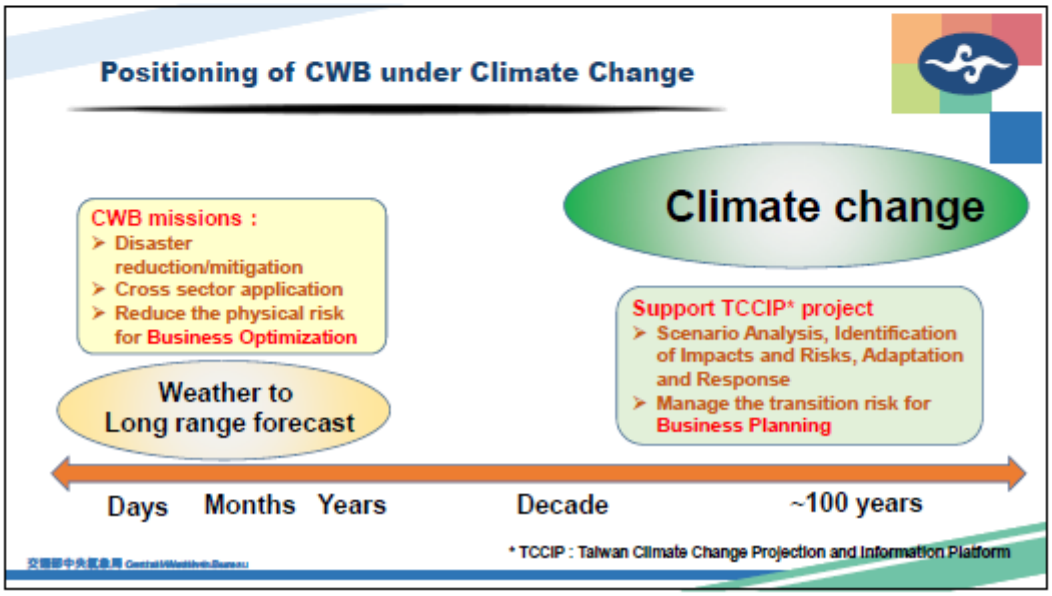

Selected Significant Climate Anomalies and Events in 2021
Below normal rainfall and temperature in January
Heavy rain in summer
High temperature and little rain in spring
Extremely high temperature in the Meiyu season
High annual mean temperature
Significant Climate Anomalies & Events
7th warmest
Jan.
Temperature
Rain
Feb. - Apr.
▼ Rain
▲ Temperature
Spring rainfall was below normal.
Warmest spring on record for Yushan station.
Climate changing
➔unfamiliar climate
➔unfamiliar weather
➔Inadequate responses
➔Disaster
Heavy Rain
Typhoon INFA and LUPIT's outer circulations brought heavy rain.
Typhoons
22 typhoons generated over the West Northern Pacific. Only CHANTHU made landfall over Taiwan.
Sep. - Nov.
Early of autumn cold air
The earliest arrival of continental cold air mass on record.
Central Weather Bureau


Pathway to
Net-Zero Emissions in 2050
MOST


2050 Net-zero transition
Strategies for transition
4 strategies + 2 foundations
Energy transition
Industrial transition
Lifestyle transition
Social transition
foundations in governance
Technology R&D
net-zero technology
negative-emission technology
Climate legislation
regulation and policy
carbon pricing and green finance
8


2050 Net-Zero Transition
12 Key Strategies
Opportunity For Climate services
1 Wind/Solar PV
2 Hydrogen
3 Innovative Energy
4 Power Systems & Energy Storage
5 Energy Saving & Efficiency
6 Carbon capture, utilization & storage (CCUS)
7 Carbon-free & electric vehicles
8 Resource Recycling & Zero Waste
9 Carbon Sinks
10 Green Lifestyle
11 Green Finance
12 Just Transition


Lifestyle Transition
Net-zero circular buildings
Passive design, adopting smart control system, developing deepened energy savings, applying highly efficient appliances, diversifing power and system integration & carbon storage in building materials
Zero-waste, low-carbon diet
Reasonable buying
Zero waste catering
Highly efficient production, sales and delivery
Regenerative agriculture
Opportunity For Climate services
Low-carbon transportation
Avoid unnecessary commuting
Accessible transportation
Convenient public transportation
Use rather than own
Light-weight design
Easy repair, upgrade and maintenance for products
Increase of service life
Recycling of components
Dialogue with citizens
Common goal
Common responsibility
Collective action
Mind-life and spiritual


Positioning of CWB under Climate Change
Climate change
CWB missions :
Disaster reduction/mitigation
Cross sector application
Reduce the physical risk for Business Optimization
Support TCCIP* project
Scenario Analysis, Identification of Impacts and Risks, Adaptation and Response
Manage the transition risk for Business Planning
Weather to Long range forecast
Days
Months
Years
Decade
~100 years
* TCCIP : Taiwan Climate Change Projection and Information Platform

Positioning of CWB under Climate Change

CWB missions
- Disaster reduction/mitigation
- Cross sector application
- Reduce the physical risk for Business Optimization

Weather to Long range forecast

Short term Climate

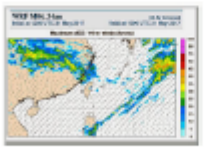
Climate change

Support TCCIP project
- Scenario Analysis, Identification of Impacts and Risks, Adaptation and Response
- Manage the transition risk for Business Planning

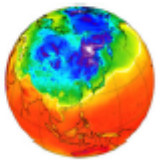
Days Months Years Decade ~100 years

- Seamless service with the scale ranged from the weather to short term climate, which is based on the internal natural variability from months to decades
- Promote public understanding of climate science and climate-related events and support the adaptation and mitigation due to the anthropogenic climate change

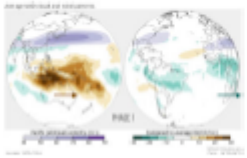
Modeling systems in CWB



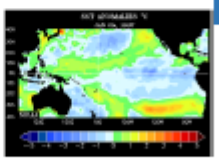
Regional weather
- CWB WRFD (5 days)
- CWB TWRF (5 days)
- CWB WEPS (5 days)
- CWB RWRF (13 hours)
- CWB CEPS (13 hours)



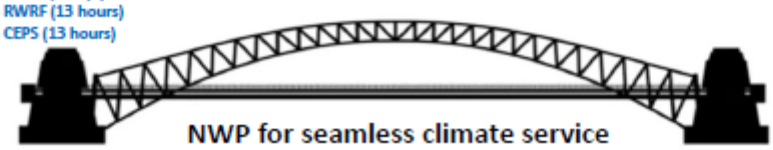
Global weather
- CWB FV3GFS (16 days)



Extended weather (S2S)
- CWB GEPS (45 days)

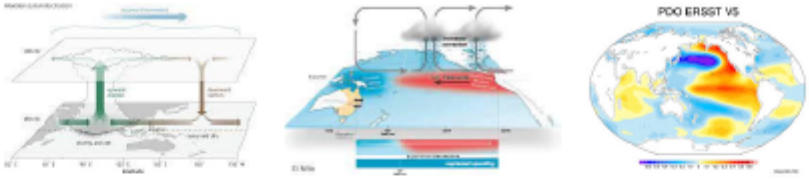


Short-term climate
- CWBCFS (8 months) (Global + RSM)



NWP for seamless climate service

Extended-Long range forecasting



Sub-seasonal → Seasonal → Inter-annual

Future cooperation

- Using the UFS based system at CWB for **extended-range ensemble forecasts** (~45 days) and **coupled model development**.
- Better understanding and the application on **the decadal forecast**
- Development of the **Statistical or AI/ML Post-Process** technical

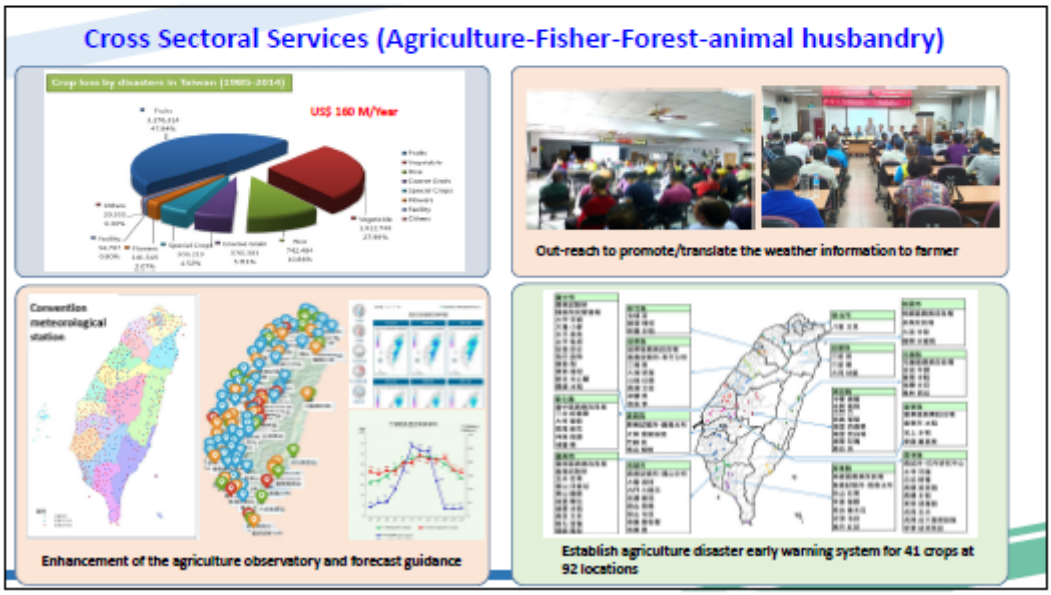
交通部中央氣象局 Central Weather Bureau

CWB's Development foci

- S2S (Sub-seasonal and seasonal) & ISI (Intra-seasonal and Inter-annual) forecasts
  - 7-day → 14-day; week2 → week3-4; 3-month → 6-month
  - Station-based → Gridded (Downscale)
  - Mean → Extreme
  - Probabilistic → Deterministic (Based on AI/ML)→Scenario based IBF
  - Research → Operation
  - Guidance →Decision making support
- Develop one-stop-shop climate services webpages
- Climate services for Net-Zero Pathways is of important

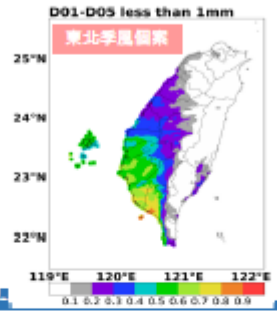
交通部中央氣象局 Central Weather Bureau


Cross Sectoral Application Services
Agriculture
Hydrology Water Resource
Green Energy
Partnership and Cooperation
Disease
Disaster Risk Reduction
Others
Human Health
13


Cross Sectoral Services (Agriculture-Fisher-Forest-animal husbandry)
US$ 160 M/Year
Out-reach to promote/translate the weather information to farmer
Convention meteorological station
Enhancement of the agriculture observatory and forecast guidance
Establish agriculture disaster early warning system for 41 crops at 92 locations

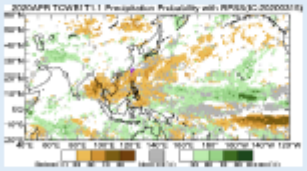
Customized product - forecast of consecutive clear days

- In Taiwan, cattle can only feed on fresh pasture during the spring and summer seasons. During the autumn and winter seasons, the growth of pasture slows down, and dried pasture becomes the main source of feed.
- When the weather is sunny, it takes 2-3 days to sun-dry the grass, while weaker sunlight may require 3-5 days. The moisture content of the pasture must be reduced to below 20% before it can be baled.
- The success rate of producing dried pasture has increased from 60% to 90% based on this product.

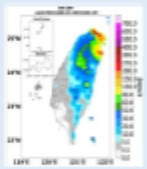


15

Cross Sectoral Services (Water Resource)

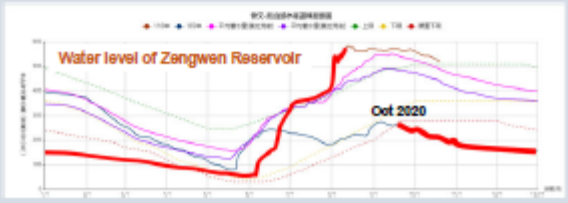


Extended-range forecasts
Monthly & seasonal outlooks



Statistical downscale to catchment area

Decision making



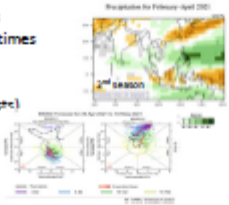
Critical situation to the recorded draught in 2021

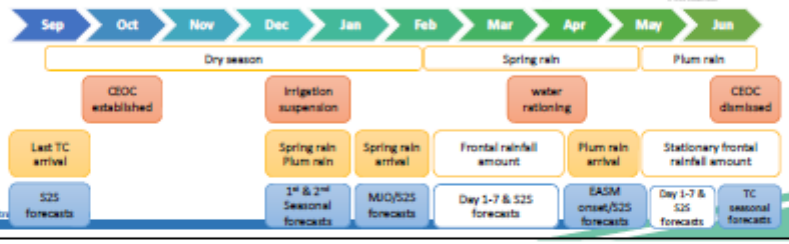
Sun-Moon Lake https://youtu.be/foy7g-L9il0

APCC's products help CWB to provide the information for drought emergency response

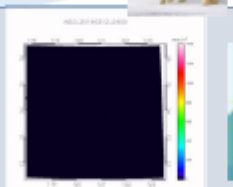
2020/21 Drought response and decision-making process

- Intensive communication between meteorological and hydrological agencies
  - Water management and working group meetings every week (46 and 38 times respectively)
- Forecast information required
  - Reservoir recharging at the beginning of dry season (TC frequency forecast)
  - Irrigation suspension in December (first and second seasonal forecasts)
  - Spring rain arrival in February (MJO / S2S forecasts)
  - Water rationing in March/April (Day 1-7 / S2S / seasonal forecasts)
  - Plum rain arrival in May (EASM onset forecasts)

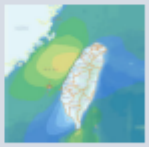




Cross Sectoral Services (Energy)

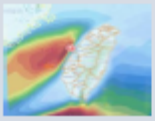


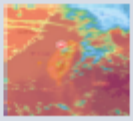
H-8 retrieved solar radiation



Climatology of the wind power

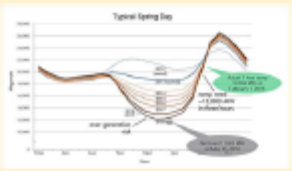
Radiation and cloud observation





Wind power and radiation prediction

- Cooperate with Bureau of Energy, Ministry of Economic Affairs
- Establish platform of applications for green energy
  - Assessment of green energy
  - Site planning and preparation
  - Real time monitoring solar radiation
  - Forecasts of wind power and short-wave radiation



Power dispatch

System maintain

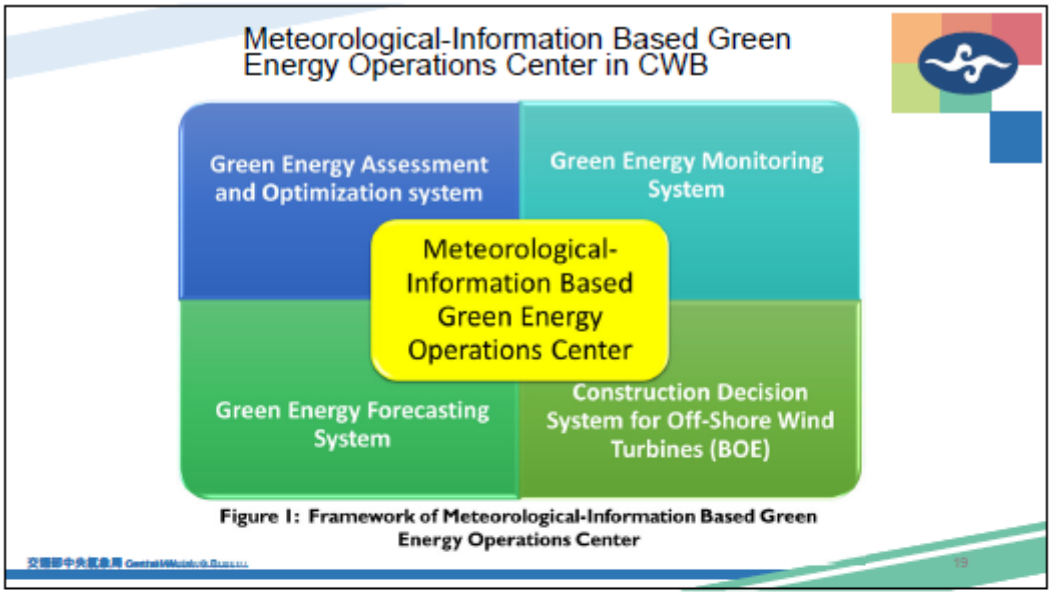
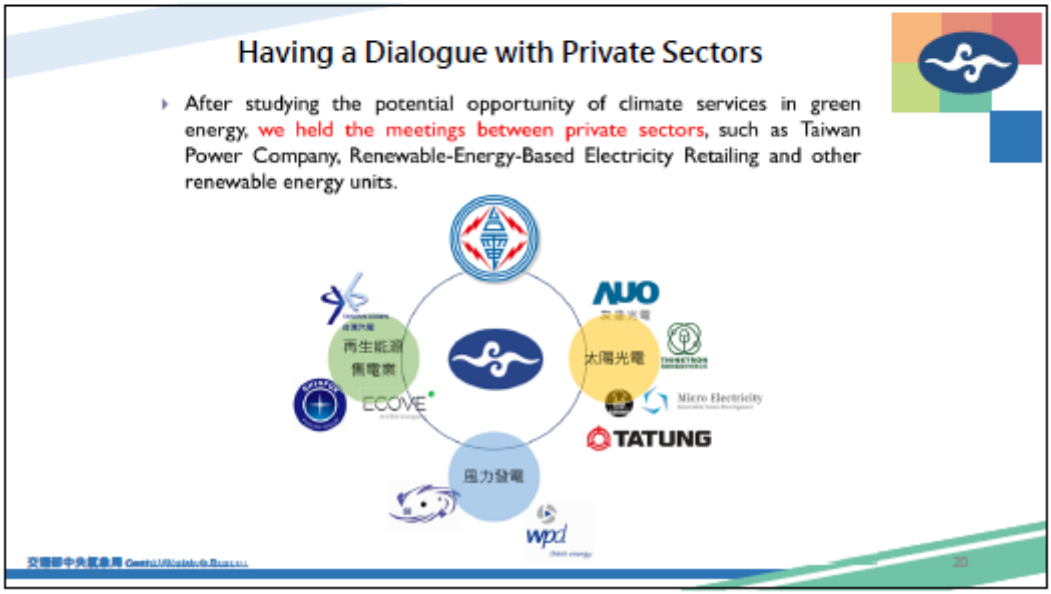
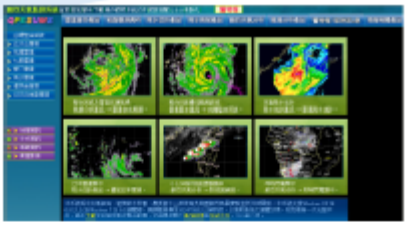
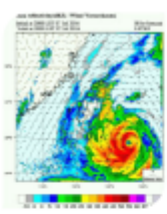


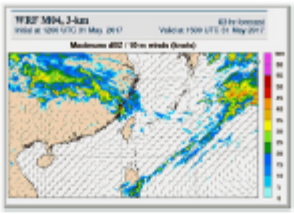
Figure 1: Framework of Meteorological-Information Based Green Energy Operations Center



Cross Sectoral Services (Disaster Risk Reduction)

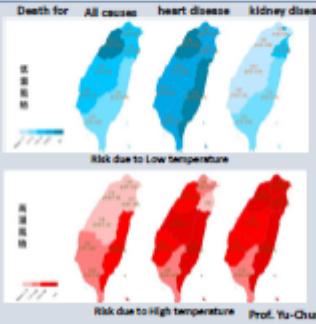






Support agencies of civil aeronautics, highway, railway, water resource, and the city/county governments to take hazard prevention and mitigation actions

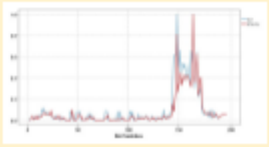
Cross Sectoral Services (Health and Disease)



Prof. Yu-Chun Wang

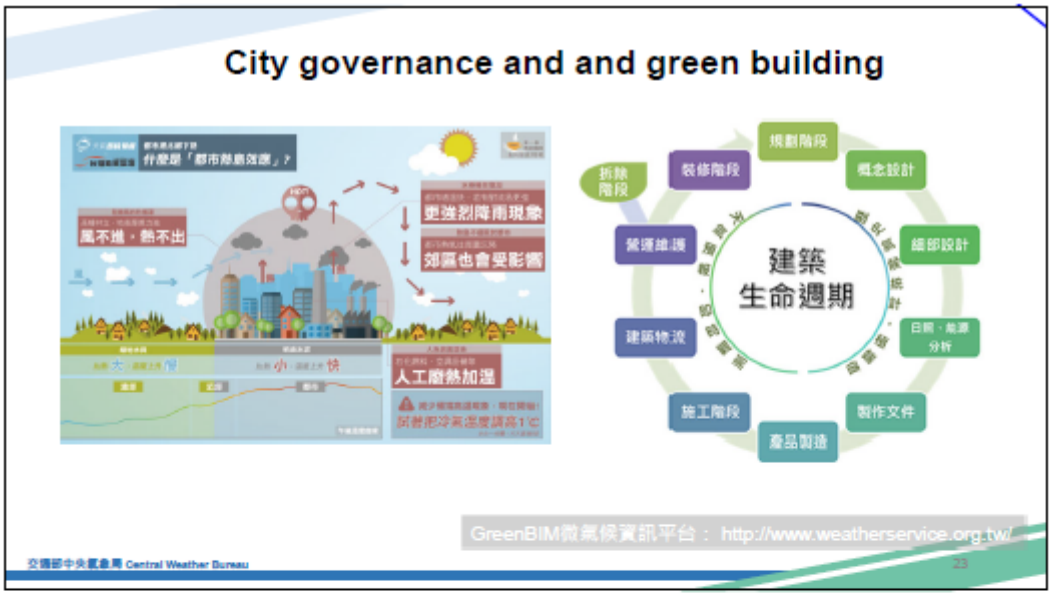
Top 3 of Presidential Hackathon

App for public health



Dengue Like Illness (DLI) Prediction

Prof. Yu-Chun Wang


City governance and and green building
什麼是「都市熱島效應」？
風不進，熱不出
更強烈降雨現象
郊區也會受影響
人工廢熱加溫
建築
生命週期
規劃階段
概念設計
細部設計
日照・能源分析
製作文件
產品製造
施工階段
建築物流
營運維護
拆除階段
GreenBIM微氣候資訊平台： http://www.weatherservice.org.tw/
交通部中央氣象局 Central Weather Bureau
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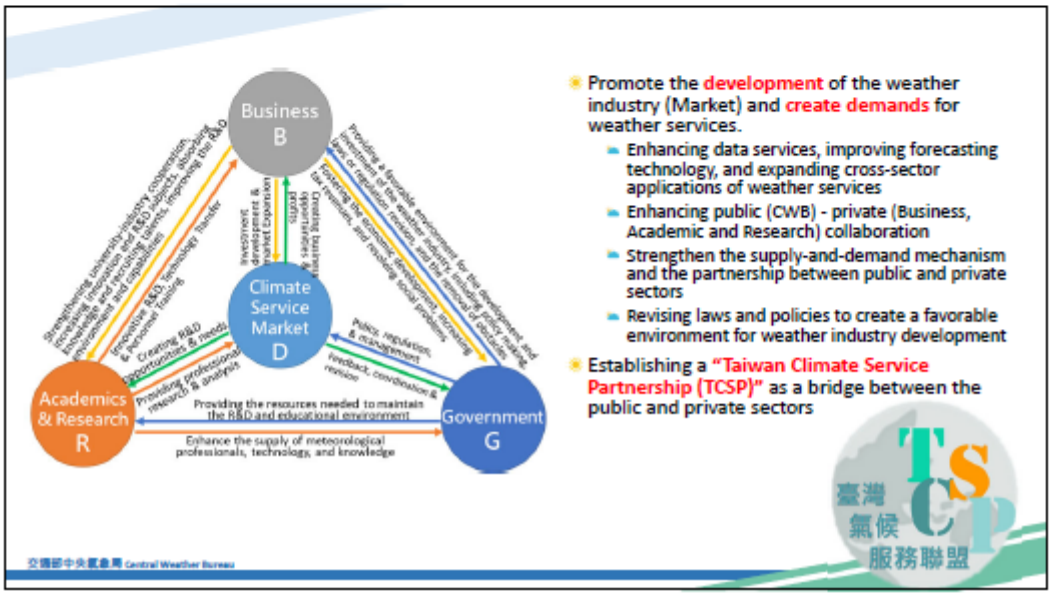
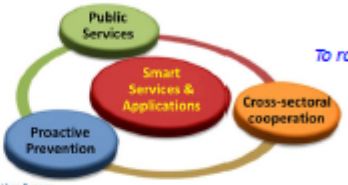
氣候變遷：瀕臨消失的旅遊景點
天下雜誌
海水溫度上升
海洋酸化
海岸侵蝕
旅行的隱形環境成本
— 觀光碳排放貢獻全球溫室氣體 8%!
孫雅彥 澳洲昆士蘭大學商學院副教授
人文與社會科學學訊
全民綠生活
Green tourism
低耗能、低污染為基礎的環保「綠色旅遊」風潮正在全台蔓延
交通部中央氣象局 Central Weather Bureau


氣候變遷風險管控及因應
首頁 / 企業永續 / 永續經營 / 氣候變遷風險管控及因應
EVERGREEN
Task Force on Climate-Related Financial Disclosures | (TCFD)
長榮海運導入氣候相關財務揭露架構 (TCFD)
• 鑑別氣候變遷與極端氣候所帶來的機會及挑戰
• 內陸積雪、洪水，惡劣海況、颱風、海霧、海冰與猛爆性低壓
• 衝擊與影響
• 供應商改變運輸路徑，造成運送時間拉長，且增加油料成本
從當下劇烈天氣的威脅橫跨10年尺度營運的衝擊


Business
B
Climate
Service
Market
D
Academics
& Research
R
Government
G
Providing the resources needed to maintain the R&D and educational environment
Enhance the supply of meteorological professionals, technology, and knowledge
Promote the development of the weather industry (Market) and create demands for weather services.
Enhancing data services, improving forecasting technology, and expanding cross-sector applications of weather services
Enhancing public (CWB) - private (Business, Academic and Research) collaboration
Strengthen the supply-and-demand mechanism and the partnership between public and private sectors
Revising laws and policies to create a favorable environment for weather industry development
Establishing a "Taiwan Climate Service Partnership (TCSP)" as a bridge between the public and private sectors
臺灣
氣候
服務聯盟

Summary

- From Seamless Forecasts to Seamless Services
- Towards A Net Zero Emission
  - Emphasizing the importance of adaptation under the premise of the mitigation.
  - Support Cross-Sectoral Risk Management, Climate Adaptation and Economical Applica
- Promote the development of the weather industry and create demands for climate services



Cooperate with international partners!
To robust the APCC economics' climate research/operation activities

交通部中央氣象局 Central Weather Bureau

Central Weather Bureau		Central Weather Administration
• Observation Division • Meteorological Instruments Center	→	• Atmospheric observation
• Telecommunications and Radar Division • Meteorological Satellite Center	→	• Remote sensing
• Applied Meteorology Division • Research and Development Center • Marine Meteorology Center	→	• Marine and Climate
• Meteorological Information Center • Weather Forecast Center • Seismological Center	→	• Numerical Information • Science development • Weather Forecasting Center • Seismological Center

交通部中央氣象局 Central Weather Bureau

Best Friendship Between APCC and CWB

The establishment of APCC

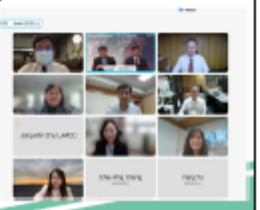
International Workshop on Climate Prediction

APCS and APCSW joint conference

2005 2016 2019 2021 2023

1. APCC and CWB signed a MOU
2. Workshop on Climate Service for Health

Asia Pacific Climate Service Workshop



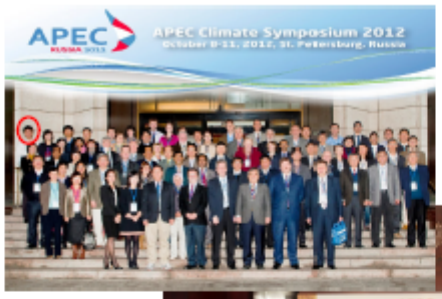
APEC Climate Symposium

The very first: 2007 (Jyh-Wen Hwu)

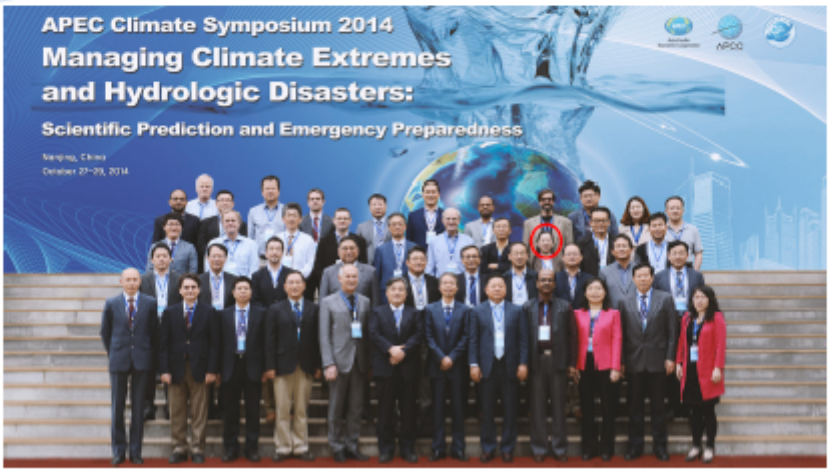
2009-2011

出國報告(出國報別：參與研討會)

出席「亞太經合會氣候中心」聯辦之「會員體工作小組會議」暨「亞太經合會氣候中心研討會與科學諮詢小組委員會議」報告



交通部中央氣象局 Central Weather Bureau




APEC
Symposium 2015
2015/11/2

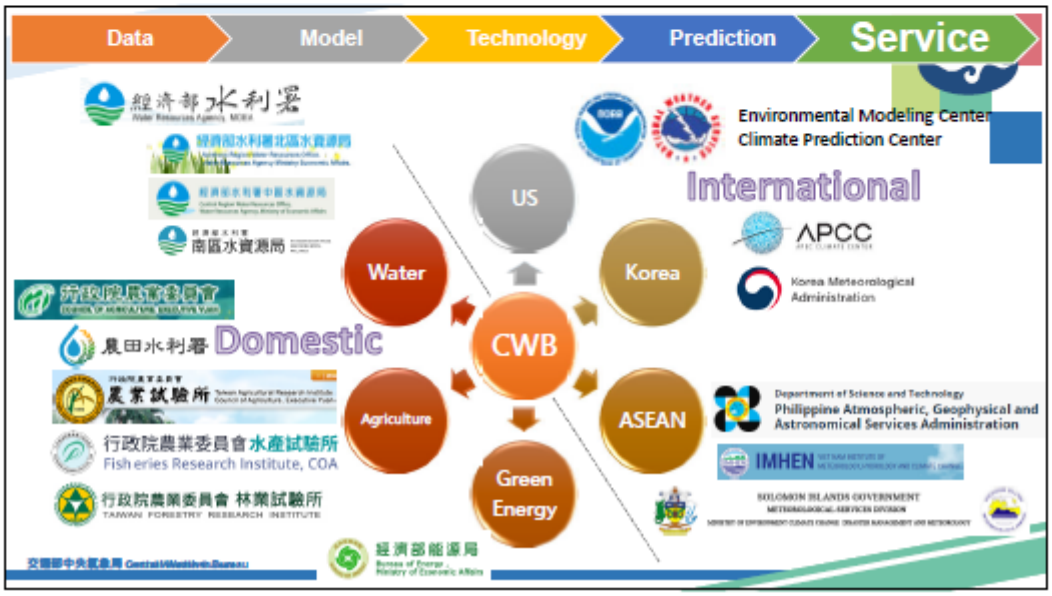

APEC
2016 APEC Climate Symposium
Piura, 16 - 18 September 2016
Asia-Pacific Economic Cooperation
APEC PERU 2016


2018
WELCOME APEC DELEGATES
PORT MORESBY | PAPUA NEW GUINEA


2019
CENTRO ASISTENCIAL
DOCENTE E INVESTIGACION
UMAG


During the Pandemic (2020-2022)
APCC Working Group Meeting 2022


Expert and Scholar Exchange
Dr. HaeJeong Kim
(2018, 2019)
2018 Subseasonal to Seasonal Training Program
(7/23-7/28)
2018 Training Program on "User-oriented Statistical Downscaling of Climate Information in Agriculture and Water Resources" (10/15-10/20)
2018 Training Workshop on Climate Information Tool Kit (10/16-10/17)


Data
Model
Technology
Prediction
Service
Environmental Modeling Center
Climate Prediction Center
International
US
Water
Korea
CWB
Agriculture
ASEAN
Green Energy
Domestic
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Korea Meteorological Administration
Department of Science and Technology
Philippine Atmospheric, Geophysical and Astronomical Services Administration
IMHEN
SOLOMON ISLANDS GOVERNMENT