出國報告（出國類別：國際會議）

出席2019年亞太氣候研討會報告
(APEC Climate Symposium,2019 APCS)

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出國期間：108年8月18日至8月25日
報告日期：108年10月28日

摘要

亞洲太平洋經濟合作會議(Asia Pacific Economic Cooperation)，簡稱亞太經合會(APEC)，下設亞太經合會氣候中心(APEC Climate Center, APCC)，其成立的宗旨係為因應氣候變遷、全球暖化的趨勢，在氣候資訊應用上提供 APEC 會員經濟體一個跨領域的溝通與互動平台，以促進亞太地區相關最新氣候監測、預測技術及應用服務等方面知識經驗交流。APCC 每年所舉辦亞太氣候研討會(APEC Climate Symposium, APCS)，邀請來自 21 個 APEC 會員經濟體的氣象水文部門代表、國際專家、學術界代表、政策制定者、民間公司、媒體及其他機構等約百餘名相關人士，共同討論氣候預測及資訊應用服務方面的新興議題。

2019 年 APCS 在 8 月 20 日至 22 日於智利的蓬塔阿雷納市(Punta Arenas)舉辦，期間並同時舉行 APCC 工作群會議。該研討會的主題為「在氣候變遷下的永續成長之路：加強氣候科學與社會的互動」，3 大次要主題分別是：1.了解極端氣候事件及其影響；2.創新的早期預警系統及管理氣候極端事件的影響，3.連結氣候資訊與社會經濟價值。研討會著眼於氣候資訊的應用、最新成果和技術的分享，並鼓勵各參與人員在會議中廣泛地交流意見，以利與會人員對極端事件及早期預警系統有更多的了解，亦期許氣候資訊能更有效率地傳播，讓氣象資訊獲得更多的社會經濟價值。

關鍵詞：

氣候變遷、氣候預報、氣候資訊應用、極端事件、永續經營、社會經濟價值。

目次

一、目的

亞太經合會(APEC)之會員包含臺灣、日本、韓國、中國大陸、菲律賓、美國、加拿大、墨西哥、俄羅斯、澳大利亞、智利、印尼、巴布亞紐幾內亞、馬來西亞、新加坡、秘魯、泰國及越南等 21 經濟實體(圖 1)，是亞太地區中一個重要的世界經濟組織，也是目前我國少數能參與的國際組織之一。

APEC 在 1998 年便有成立氣候中心的規劃，經數年努力，亞太經合會氣候中心(APEC Climate Center, APCC, http://www.apcc21.net)終於在 2005 年於韓國釜山成立。APCC 蒐集包含我國中央氣象局與各個先進國家(圖 2)的天氣及短期氣候模式預報產品，透由多國系集模式(Multi Model Ensemble, MME)的整合及分析，提供 APEC 會員乃至於全世界各地的短期氣候預報資料，協助各國對可能面臨的氣象災害提早因應。同時，APCC 自 2004 年起，每年配合「APEC 總結資深官員會議(CSOM)」、「APEC 部長級年會(AMM)」及「APEC 經濟領袖會議(AELM)」所擇定之經濟體(國家/地區)，例行舉辦亞太氣候研討會(APEC Climate Symposium, APCS)，是為 APCC 年度重要工作及盛事。

2019 年的 APCS 由智利氣象局主辦，8 月 20 日至 22 日在該國最南端的蓬塔阿雷納斯市(Punta Arenas)舉辦，主題為「在氣候變遷下的永續成長之路：加強氣候科學與社會的互動」，大約 100 名來自世界各地的與會人員，成員包含各經濟體的科學家、政策制定者、氣象水文部門代表、專家、學界代表、民間公司及媒體等其他機構等相關人士，研討會期間也同時召開 APCC 年度工作小組會議(Working group meeting, WG)。蓬塔阿雷納斯市位於智利南部，是麥哲倫-智利南極大區的首府，也是麥哲倫海峽最重要的港口城市，更是進入南極的門戶，尤其在巴拿馬運河修築前，其獨特的地理位置成為大西洋與太平洋間過往船隻的加煤和加油站，即使到現在仍是各國科學考察船隊進入南極前的重要前進基地及後勤補給站。

本年度的 APCS 研討會，中央氣象局林雨我主任秘書及氣象科技研究中心李明營技士奉派與會，臺灣方面與會的還有中華經濟研究院(CIER)科技政策評估研究中心主任林桓億博士，以及國家防災中心災防資訊組張子瑩組長。另外，旅美的美國加州大學余進義教授亦受邀參與此次研討會並發表論文。林主任秘書除參加研討會外，也代理中央氣象局葉天降局長以臺灣代表身分出席工作小組會議，同時在該小組會議中報告「中央氣象局的氣候服務之現況與未來」，向與會的各經濟體代表分享臺灣的經驗，增加我國的國際能見度。

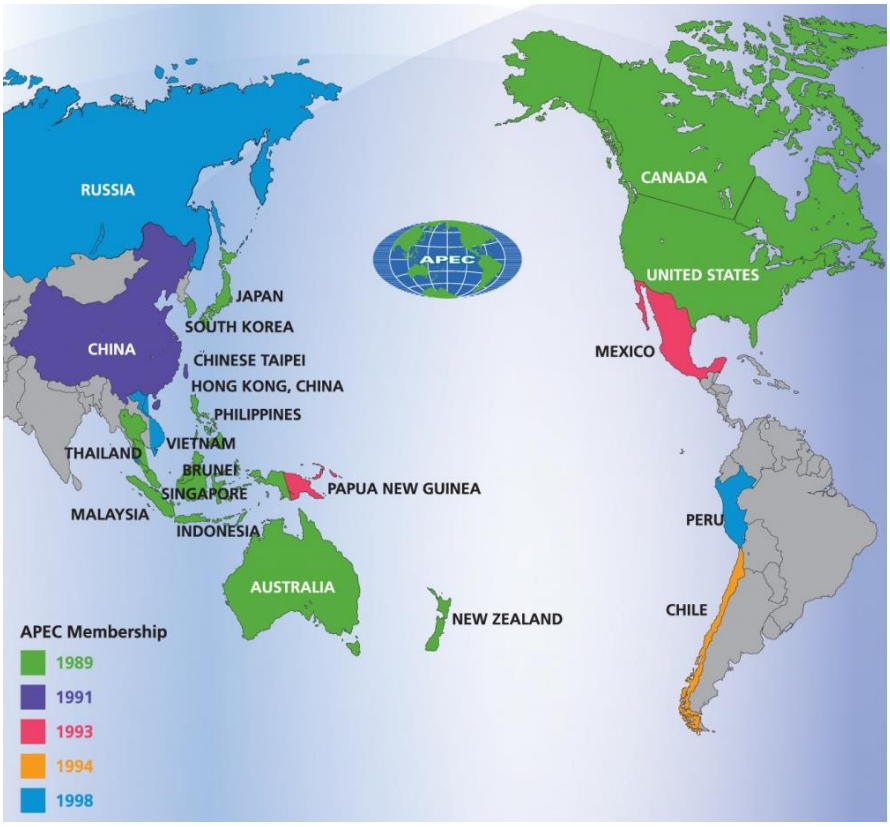


圖 1：APEC 會員及入會年份。(圖檔來源 http://www.transpacificproject.com)

The participating organizations and institutes in the APCC-MMEs:

Meteorological Service of Canada	International Research Institute for Climate and Society	Beijing Climate Center / CMA	Met Office	Australian Government Bureau of Meteorology	Center for Ocean-Land-Atmosphere Studies
Institute of Atmospheric Physics	Pusan National University	National Aeronautics and Space Administration	Hydrometeorological Centre of Russia	Central Weather Bureau	Korea Meteorological Administration
National Centers for Environmental Prediction	Voeikov Main Geophysical Observatory	Japan Meteorological Agency	Euro- Mediterranean Center on Climate Change	Meteorological and Hydrological Weather Service of Peru	

圖 2：參與 APCC 多國系集模式的成員，中央氣象局(第 2 排右 2)亦是其中一員。(圖檔來源 http://www.transpacificproject.com)

二、過程

此次與會行程說明如下：

日期	地點與相關工作內容
2019/8/18~8/19	出發前往，臺北→荷蘭阿姆斯特丹→智利聖地牙哥→蓬塔阿雷納斯。
2019/8/20~8/22	參加 2019 年亞太氣候研討會(APEC Climate Symposium, APCS) 1. 8/20, 08:00~12:30：註冊、開幕、關鍵議題講座。 2. 8/20, 13:30~17:30：主題一，了解極端氣候事件及其影響。 3. 8/20, 18:00~20:00：迎賓晚宴。 4. 8/21, 09:00~13:00：主題二，創新的早期預警系統及管理氣候極端事件的影響。 5. 8/21, 14:00~18:30：主題三，連結氣候資訊與社會經濟價值。 6. 8/22, 09:00~12:10：綜合討論及閉幕典禮。 7. 8/22, 14:00~18:00：參訪 Fuerte Bulnes。
2019/8/23~8/25	返國，智利蓬塔阿雷納斯→聖地牙哥→法國巴黎→臺北。

此次研討會中各演講者的簡報及相關資料，APCC 整理在以下網址：https://www.apcc21.org/ic/apsView.do?lang=en&bbsId=BBSMSTR_000000000031&nttId=6021&pageIndex=1&recordCountPerPage=10&searchCnd=&cate1=&searchWrd

(一)研討會開幕式

2019 APCS 研討會在智利的麥哲倫大學演講廳舉行，議程如附錄 1。開幕式中有多位智利當地的長官及貴賓致詞(圖 3)，最後，與會人員移步至會議大樓前團體合照(圖 4)，來自臺灣的 5 位人士，亦在會場留下了合影(圖 5)。

圖 3：2019 APCS 研討會開幕式。

圖 4：APCS2019 開幕式的團體合照(照片來源：APCC)。

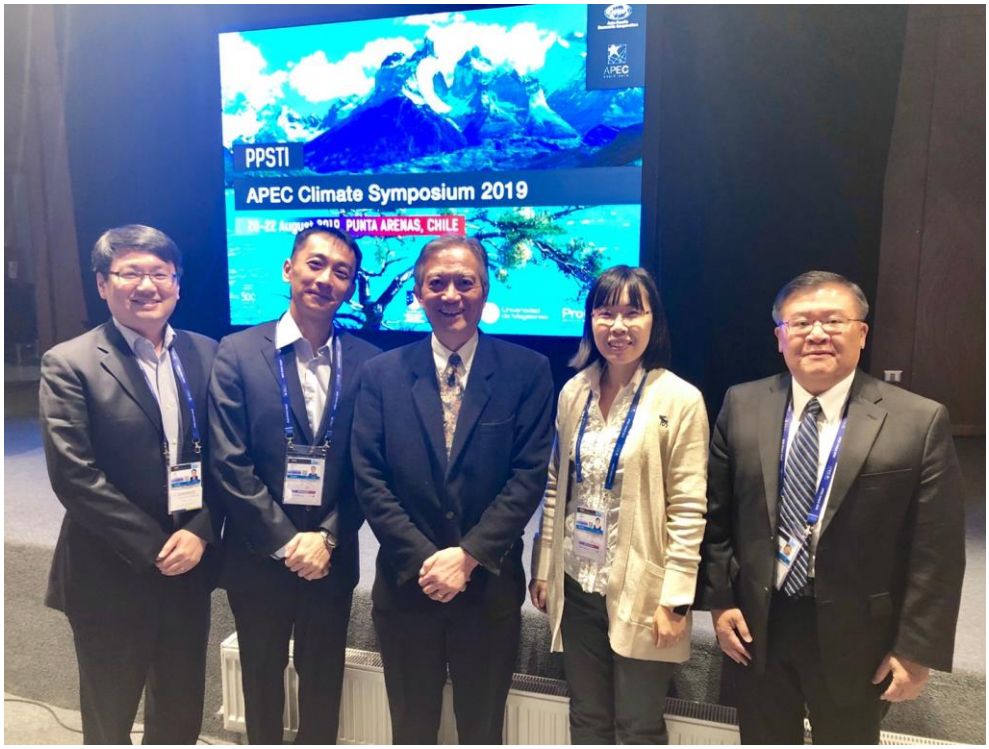


圖 5：APCS2019 會場中，來自臺灣的 5 位人士。由左至右分別是中華經濟研究院林桓億主任、中央氣象局李明營技士及林雨我主任秘書、國家防災中心張子瑩組長、美國加州大學余進義教授。

開幕式後，開始了第 1 日上午的關鍵議題講座，緊接者是 3 大主題的邀請演講與討論。主題分別為：

1、了解極端氣候事件及其影響(Understanding of Extreme Climate Events and their Impacts)。
2、創新的早期預警系統及管理氣候極端事件的影響(Innovating Early Warning System to Manage Impacts of Climate Extremes)。
3、連結氣候資訊與社會經濟價值(Connecting Climate Information to Socio Economic Values)。

(二)關鍵議題講座

關鍵議題的主題為「氣候服候應用於氣候快速變遷下的永續發展(Climate Services for Sustainable Development under a Rapidly Changing Climate)」，分別邀請智利南極研究所(Chilean Antarctic Institue)主任 Marcelo Leppe 博士、英國杜倫大學(UK Durham University)氣候學教授 Glenn McGregor 博士、世界衛生組織(WHO)與世界氣象組織(WMO)聯合辦公室負責官員 Joy Shumake-Guillemot 博士 3 位進行演講。

第 1 位演講者，Marcelo Leppe 博士由智利的冰川減少出發，討論到全球溫度上升、海洋酸化、熱浪、珊湖生態破壞等因氣候變遷帶來的衝擊，也提到智利是氣候變遷、全球暖化現象相當明顯的國家，因此也正是今年特別選定智利做為 APEC 系列會議舉辦國的原因之一。

第 2 位演講者，Glenn McGregor 教授則說明氣候是有實用價值的科學，其目的在於產生可實際應用的知識及服務，使民眾及決策者能應用於氣候風險管理方面。而氣候風險管理要同時綜合考慮到社會經濟和環境等問題，其主要價值為增加或保持現有的社濟利益，亦能減少潛在危害或損失。要提高氣候風險的管理能力有許多方面可努力，其中包含高品質的氣候資料庫、適當的氣候服務能力、跨領域的合作及溝通。Glenn McGregor 教授亦以索羅門群島為例，由統計資料顯示 2015 至 2016 年的腹瀉人數較多，他推測是因為當時適逢超級聖嬰年，造成索羅門群島降水偏少，進而影響到當地的飲水品質。而且，他發現聖嬰指數高峰值若領先腹瀉人數高峰值 6 個月時，兩者有較高的相關性，此點說明若能適當地應用氣候資訊，就能達到事先預警的效果。

第 3 位演講者，Joy Shumake-Guillemot 博士談論到健康與氣候的連結，她也認為氣候服務要與產業人員之間要多交流、溝通，氣候資訊的提供要以使用者角度出發。Joy Shumake-Guillemot 博士指出，為健康提供量身定製的氣候資訊之比率

偏低，如在西北太平洋及東南亞區域中的比率均不到 2 成(圖 6)。她亦提到 WHO 認知到公共衛生及健康與氣候變遷、全球暖化現象間有高度相關，因此與 WMO 特別成立聯合辦公室，負責兩個領域間的聯繫與合作，也提出衛生、環境與氣候變遷全球戰略草案(Draft WHO global strategy on health, environment and climate change, https://www.who.int/phe/ publications/global-strategy/en)，由於氣候變化導致全球許多地區的極端事件日益頻繁及強烈，進而對健康產生很大影響。

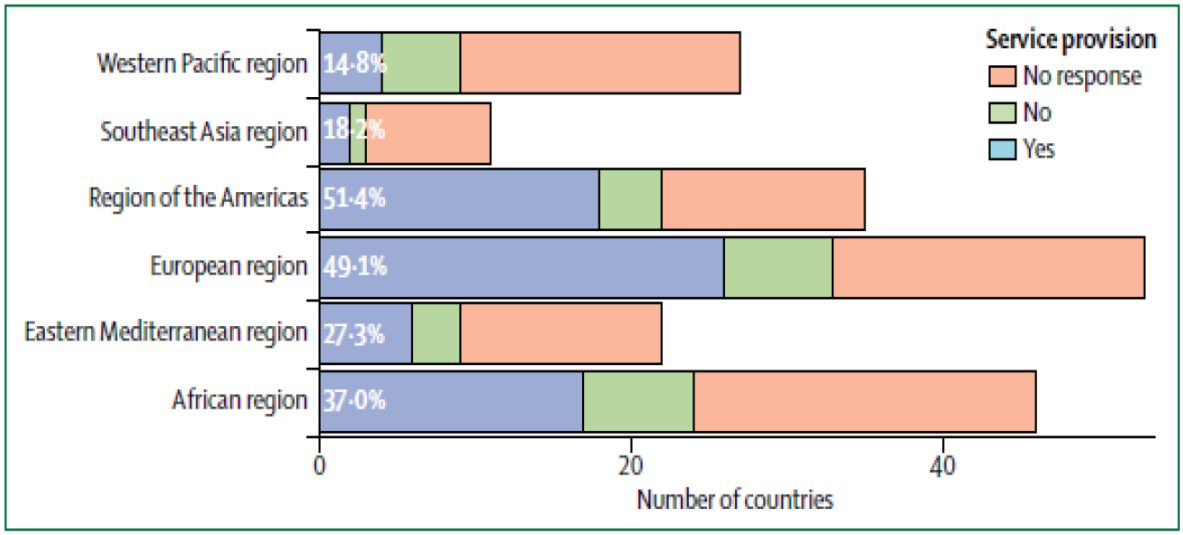


圖 6：各國氣象及水文主管機關，是否提供健康相關之氣候服務的統計。3 種顏色分別代表無回應(橘)、否(綠)、是(藍)。此圖僅統計世界健康組織的會員國，由上而下為西太平洋、東南亞、美洲、歐洲、中東及非洲。(摘自 Joy Shumake-Guillemot 博士的簡報)。

(二)主題研討

主題一：了解極端氣候事件及其影響

美國氣候預測中心(Climate Prediction Center, CPC)的 Arun Kumar 博士在演講中介紹 3 個網站，首先是韓國氣象廳(Korean Meteorological Administration, KMA)維運的長期預報系集模式(Long-Range Forecast Multi Model-Ensembles, LRFMME, https://www. wmolc.org)，使用來自全球 13 個單位模式資料，可提供月及季預報資料；第 2 個網站為英國氣象局(UK Met Office)維運的年際至年代際氣候預報(Annual to Decadal Climate Predictions, ADCP, https://www.wmolc-adcp.org)，蒐集了北半球 15 個單位的模式資料，提供未來 1 及 1 至 5 年的預報，約在每年的 11 或 12 月更新；Arun Kumar 博士所介紹的第 3 網址，為次季節至季節預報計畫(Sub-Seasonal to Seasonal, S2S, http://s2sprediction.net)，主要提供後報(hindcast)及即時(但有延遲)的預報資料，預報的時間尺度為 1 至 4 週。事實上，上述的 LC-LRFMME 及 S2S 都是目前中央氣象局常參考的資料之一。

旅美的余進義教授，目前任教於美國加州大學，是中央氣象局相對熟識的學者。余進義教授的演講對聖嬰現象提出新看法，他指出聖嬰可分類為東太平洋(Eastern Pacific El Niño, EP)及中太平洋聖嬰(Central Pacific El Niño, CP)2 種形態。EP 與 CP 不僅海溫形態及形成機制不同，對全球氣候的影響也不盡相同。余進義教授進一步說明，由於 CP 是由熱帶外的大氣趨動，所以 CP 的可預報性較低；相對來說 EP 是熱帶海、氣交互作用形成的，可預報度較高，大約有 9 個月的預報能力。余教授指出，在 21 世紀後，聖嬰轉為以 CP 形態為主，這將使得 21 世紀後的聖嬰變得更加難以預報。至於造成聖嬰形態轉變的原因，他則認為是大西洋多年代際(Atlantic Multi-decadal Oscillation, AMO)之相位由負轉正的影響。

Paul Gregory 博士為澳洲氣象局(BoM)的資深預報科學家，他提到數十年間在澳州發生的氣候變遷現象，包含澳洲南部在 4 至 10 月期間變得較乾，澳洲北部的濕季在近 20 年則變得更加多雨，澳洲熱浪事件變得更加頻繁，也提到了海平面近期以每年 3 公分上昇(圖 7)等全球方面的問題。

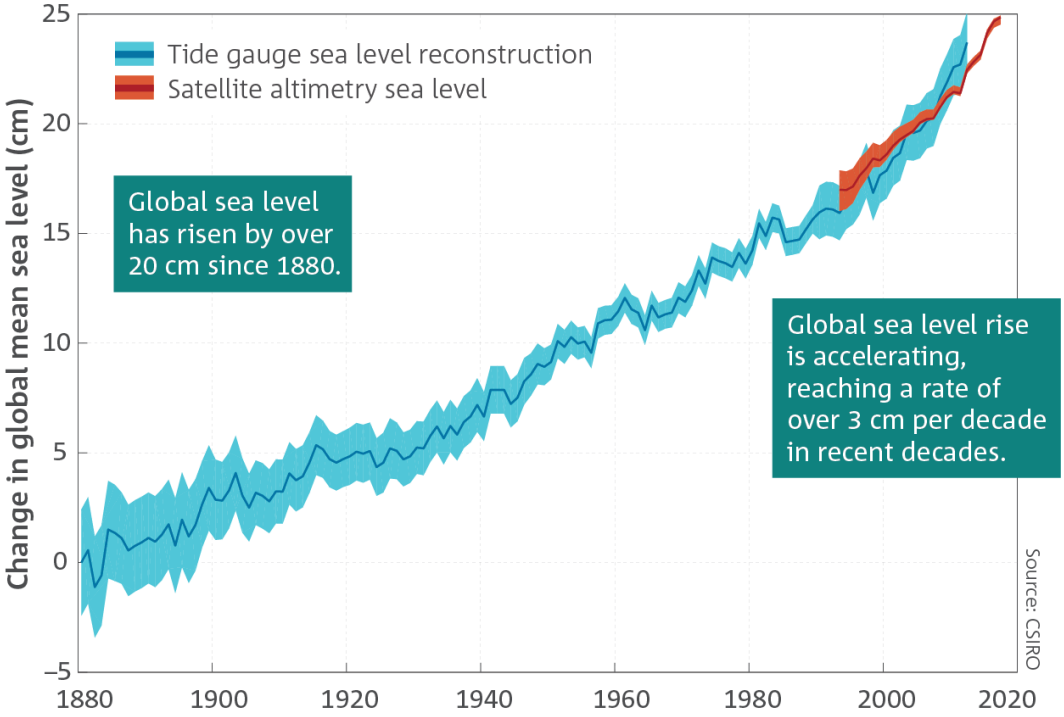


圖 7：全球平均海平面變化時序圖。(摘自 Paul Gregory 博士的簡報)。

主題一的最後兩者講者，分別為智利氣象局的預報人員 Jose Vicencio 以及智利 Antarctic Gaia Research Center 的研究人員 Jorge Carrasco 博士。兩位當地專家主要談論智利的極端天氣及氣候事件，如洪水、龍捲風、熱浪、乾旱、森林大火等，亦述及智利有溫度上升(尤其是低溫)、冰川面積減少等氣候變遷議題。

主題二：創新的早期預警系統及管理氣候極端事件的影響

Tim Manning 博士是美國太平洋災難中心的高級顧問，演講中談論到氣象災害的發生頻率、強度、影響層面及區域廣度均有增加，例如因海平面上昇，美國沿岸的洪害發生頻率已較以往來得高；也提到現今及未來在暖化背景之下，過去在計算各種災害(如洪水、乾旱)的重現期公式可能已不適用。

韓國 APCC 氣候分析組(Climate Analytics Department)的研究人員 Daeha Kim 博士專精於乾旱監測，他提到乾旱現象在地表出現的過程有延遲現象，降水不足要過一段時間後才會發生乾旱，即乾旱指標在時間上會落後降水量。Daeha Kim 博士進一步表示，僅用降水來定義乾旱指標是不足的，還要同時考慮氣候條件；而且，由於降水有不連續性(有雨才有值，不下雨時為零)，且預報降水有高度不確定性。相對來說，Kim 博士認為使用蒸散發來看乾旱比較合適，因為蒸散發只需考慮到太陽輻射量、平均溫度、濕度、風速這 4 個氣象的常規觀測項目，蒸散發沒有降水的不連續性問題，而且可預報度比降水高。但 Kim 博士也表示，目前只有少數組織使用蒸散發來監測乾旱，例如美國的蒸發需求乾旱指數(Evaporative Demand Drought Index, EDDI, https://www.esrl.noaa.gov/psd/eddi/)。

由於工作小組會議與研討會同時間舉行，林主任秘書與李明營技士為參加該會議，無法聆聽主題二的後半段演講內容及記錄心得。至於工作小組會議的內容，於第(五)小節再說明。

主題三：連結氣候資訊與社會經濟價值

Jin Ho Yoo 博士是 APCC 氣候服務及研究組(Climate Services and Research Division)主任，他報告 APCC 在客製化氣候服務方面所做的努力，包括 APCC 的氣候預報能力正逐漸在改善，並以顧客導向出發，進行許多降尺度研究及分析，也建立了友善的資訊瀏覽系統，讓氣候預報資訊能應時適地的被應用於各層面。

Sally J. Edwards 博士為泛美衛生組織(Pan American Health Organization)的區域顧問(Regional Advisor)，聚焦於健康和氣候資訊之間的連結。她認為，極端天氣早期預警系統是建立氣候科學與健康兩者之間的橋樑。她指出要建立一個良好的預警系統，必須要能蒐集即時的流行疾病的資訊，亦要有過去的大量歷史資訊。藉由健康與氣象兩組大量資料的深入分析，找到兩者之間的關聯性。經過上述步驟，將氣候訊息轉換為可實用、提供決策參考的資訊，這有賴於健康與氣候體系之間的相互合作。

智利大學地理系的 Hugo Romero Aravena 教授及麥哲倫大學研究中心的 Sergio Radic Schilling 教授都是智利當地的學者，分別談論到都市效應及麥哲

倫草原監測系統。其中，在麥哲倫草原監測系統中，智利利用衛星資料及地面觀測站建構出數值地圖資料，可用來監測植被、溫度、雪蓋、蒸發散等要素的空間及時間變化。

美國經濟專家 Jeffrey K. Lazo 博士，分享一本可在網路下載的「評價天氣和氣候：氣象和水文服務的經濟評估」電子書(Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services, https://library.wmo.int/doc_num.php?explnum_id=3314)，該書共有 308 頁，Jeffrey K Lazo 博士也是眾多作者之一。接著，他提到了天氣資訊價值鏈(Weather Information Value Chain, 圖 8)包含了 7 個環節，分別是①實際發生的天氣事件(包含氣候及水文)、②監測系統(包含衛星、雷達、氣象站…)、③模式及預測(包含數值天氣、氣候模式的客觀結果，及實際天氣、季節預報、即時預警…)、④氣象資料的傳播及通訊(包含網路、電視、電台、電話等傳播方式)、⑤使用者對氣象資訊的感受及闡釋、⑥決策(如民眾或政府接收到氣象資訊後的因應作為)，以及⑦經濟價值(在採取因應作為後，所得到的利益)。Lazo 博士強調，氣象資訊的最終價值取決於決策者的理解能力，並做出的應對作為，從而評估是否由其中達到降低成本、減少損失、增加利潤等益處。他進一步提到，在天氣資訊價值鏈中的每個環節都要負責單位，每個單位要能相互合作，將資訊正確地傳達下去。另外，研究分析發現，受天氣因素影響的國內生產總值(Gross Domestic Product, GDP)，在美國每年大約高達 4850 億美元(約占 2008 年總額的 3.4%)。Lazo 博士舉一個調查報告指出，美國人願意一戶平均每年花費 286 美元來支付其氣象局的運作，全美總額約 315 億美元，約是該局經費 51 億美元的 6.2 倍，說明氣象資訊還是非常有價值的。最後，Lazo 博士建議，氣象及水文服務都應進行經濟學分析，這將有助於資料提供者更了解使用者需求，並創造的更多社會經濟價值。

圖 8：天氣資訊價值鏈(摘自 Jeffrey K Lazo 的簡報)。

(四)綜合討論

2019 APCS 研討會全部議程的最後一天上午，由 APCC 的 Seantae Kim 博士、Boksoon Myoung 博士及智利大學的 Hugo Romero 教授等 3 人，分別針前述 3 大主題進行議題討論回顧與小結。最後，由來自美國的經濟學家 Jeffrey Lazo 博士等 6 位專家學者，帶領與會人員共同討論這次研討會的相關議題。

在綜合討論中，有許多討論聚焦於氣象資訊如何傳播，林主任秘書在研討會中分享中央氣象局的調查報告(圖 9)，指出在臺灣約有 90%的民眾是透由電視來取得氣象資訊的管道，而年輕人則有較高比率來自智慧型手機，藉由了解社會大眾獲取氣象資訊的方式，中央氣象局就能調整資訊傳播的策略與形式，讓氣象資訊服務更有效率地推廣。中華經濟研究院的林桓億博士呼應林主任秘書的發言，說明中央氣象局與中華經濟研究院近年來密切地官、學合作，共同了解使用者對氣象資料的需求面向，並進行許多氣象服務推廣活動，有助於提高中央氣象局所提供的資料之經濟價值。

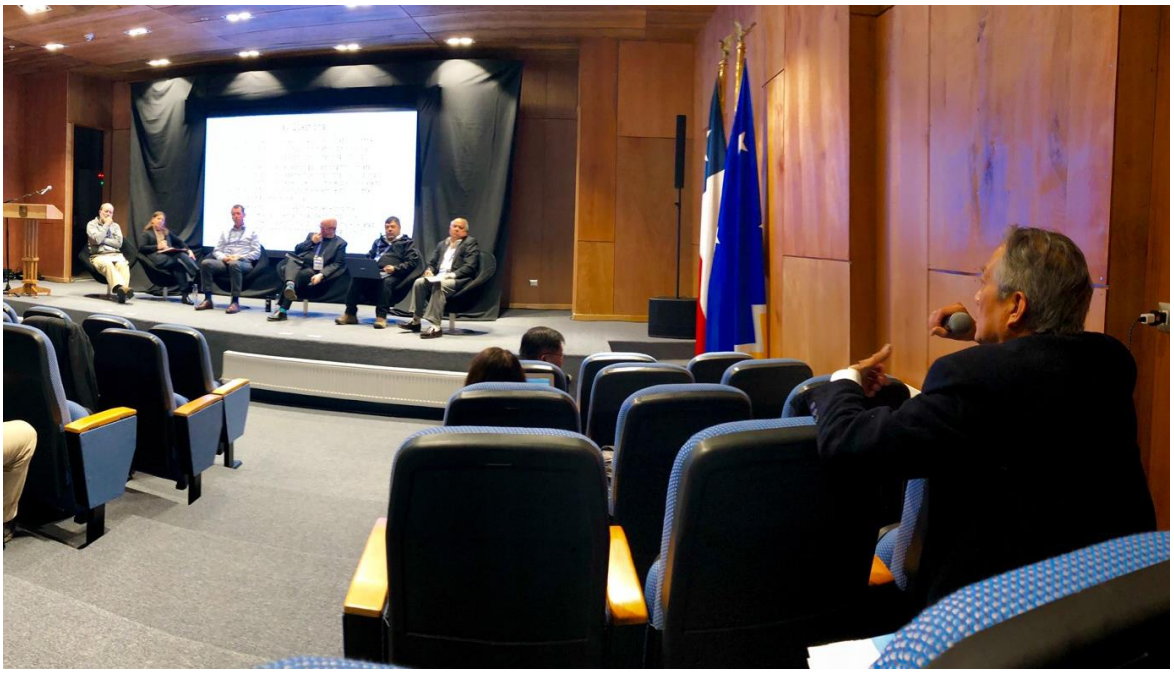


圖 9：研討會中的綜合討論。

(五)工作小組會議

APCC 每年於 APCS 研討會舉辦期間，同時舉行 APCC 工作小組會議(APCC Working Group Meeting)，該會議由 APCC 執行長與各經濟體會員各推派 1 人組成，對 APCC 之運作提供建議以及為 APCC 與各會員之聯繫窗口。本年度 APCC 工作小組會議於 8 月 21 日的 10 至 12 時舉行，議程如附錄 2，參加人員包含：

- 會議主席：輪值國代表，智利氣象局副局長 Enrique Garrido Segovia 博士。
- 會議副主席：Won-Tae Kwon 博士(APCC 執行長)。

- 出席成員：
  - ✓ APCC 氣候服務及研究組主任：Jin-Ho Yoo 博士。
  - ✓ 臺灣代表：林雨我博士(中央氣象局主任秘書)
  - ✓ 澳洲代表：Dr. Paul Gregory (Senior Prediction Scientist, Bureau of Meteorology, Australia)。
  - ✓ 印尼代表：Mr. Muhammad Agung Fauzi (Head of Sub Division for Environment Climate Information, Applied Climate Information Services Center, Agency for Meteorology Climatology and Geophysics)
  - ✓ 日本代表：日本氣象廳 Mr. Takayuki Tokuhiro (Senior Coordinator for Climate Modeling, Japan Meteorological Agency)。
  - ✓ 馬來西亞代表：Ms. Khazainani Salleh (Director, National Climate Centre, Malaysian Meteorological Department)。
  - ✓ 紐西蘭代表：Dr. Brett Mullan (Principal Scientist, National Institute of Water and Atmospheric Research)。
  - ✓ 菲律賓代表：Ms. Rosalina De Guzman (Assistant Weather Services Chief, Climate and Agro-meteorology Division, Philippine Atmospheric, Geophysical & Astronomical Services Administration, the Philippines)。
  - ✓ 巴布亞紐幾內亞代表：Mr. Kasis Inape (Assistant Director of Climate and Special Services, National Weather Service, Papua New Guinea)。
  - ✓ 秘魯代表：Mr. Gustavo De La Cruz Montalvo (Climate Specialist, Department of Meteorology and Atmospheric Environment Assessment, National Service of Meteorology and Hydrology, Peru)。
  - ✓ 泰國代表：Mr. Maytee Mahayosanunta (Director of Weather Forecasting Division, Thai Meteorological Department, Thailand)。
  - ✓ 越南代表：Mr.Le Thanh Hai (Vice Administrator, VietNam Meteorology and Hydrology Administration)。
- APCC 工作人員
  - ✓ 業務及國際組代理主任：Sangwon Moon 女士。

✓ 國際事務組計畫經理：Suhee Han 女士。

- 觀察員

✓ Mr. Gaston Torres (Deputy Director, National Weather Service of Chile)

✓ 李明營博士(中央氣象局氣象科技研究中心技士)

工作小組會議由會議主席致詞開始，在各位與會人員簡短自我介紹之後，由 Jin-Ho Yoo 博士說明 APCC 近況，他指出近年 APCC 的經費及人力都有所縮減；又說明 APCC 預報能力有逐漸進步，尤其在第 3、4 週的預報能力甚至比歐洲模式更好。接著由日本、紐西蘭、巴布亞紐幾內亞代表各自報告該國的氣候預報及服務之現況與未來規劃。中央氣象局林主任秘書亦分享了臺灣在氣候服務的現在經驗與未來規劃(圖 10，簡報內容請見附錄 3)。由氣候服務架構講起，接著說到氣候服務的產品及傳播，再講述到在農漁業、水利、電力等方面的跨領域合作，最後分享國際交流合作的案例，並藉此機會邀請與會人士，踴躍參與中央氣象局於今年 10 月 28 至 30 日在臺北舉辦的亞太氣候服務工作坊(Asia Pacific Climate Service Workshop)，此份分享報告獲得許多迴響及討論，其中菲律賓及越南代表特別希望取得簡報電子檔。

在工作小組會議的綜合討論中，主席 Enrique Garrido Segovia 博士提到工作小組會議一年才舉行一次，在年度會議間的空檔期，各會員體若有需要討論的議題，提議是否能以視訊會議方式舉行，但澳洲代表 Paul Gregory 博士認為，各會員體時區不同，很難找到大家都有空的時間來進行視訊會議。APCC 執行長 Won-Tae Kwon 博士則表示，也許可以建立一個網路群組平台，各會員體可把想討論的事件放在平台上。APCC 執行長 Won-Tae Kwon 博士說明，各會員如有類似中華台北所提到的舉辦亞太氣候服務工作坊訊息，APCC 非常願意代為協助宣傳。此外，會議中有討論到網路普及率的議題，林主任秘書也分享臺灣的經驗，指出多數的臺灣農民沒有經常使用智慧型手機的習慣，仍以電視及電台為主要的氣象資訊來源；同時提到臺灣已建立了災防告警系統(Public Warning System)，當有地震發生後或預期將有大雷雨發生時，可透過細胞廣播訊息的方式，即時將示警訊息傳遞至智慧型手機或電視，以達即時預警及減災效果，獲得與會代表廣泛地討論。最後，與會人員合照留影(圖 11)，並相約明年再見。會議紀錄如附錄 4。

圖 10：林雨我主任秘書(左下角)在工作小組會議報告「中央氣象局的氣候服務之現況與未來(Climate service in CWB, Now and future.)」。

圖 11：2019 APCC 工作小組會議出席人員合影。前排左 1 為 APCC Sangwon Moon 女士，左 2 至 4 為馬來西亞、巴布亞紐幾內亞、菲律賓代表，左 5 為 APCC 執行長 Won-Tae Kwon 博士，左 6 及 7 是泰國及越南代表，最右為我國代表林雨我主任秘書；後兩排左 1 至 2 為印尼、日本代表，左 3、4 為智利氣象局兩位的副局長 Gaston Torres、Enrique Garrido Segovia 博士(亦為會議主席)，左 5 至 7 為澳大利亞、紐西蘭、秘魯代表，右 2 為 APCC 的 Jin-Ho Yoo 主任，最右為李明營技士。(照片由 APCC 提供)。

三、心得與建議

本次奉派出席 2019 年 APCS,在研討會聆聽來自各領域的專家學者,講述氣候變遷、極端天氣與氣候事件、早期預警系統，以及連結氣候資訊與社會經濟價值等議題，並與各國代表面對面交流，著實吸收到不少新知識，收穫尚稱豐碩。

在此次研討會中，許多專家學者均認為氣候變遷已經影響我們的日常生活，所有人都必須面對氣候變遷所帶來的衝擊。但對非氣象專業人員來說，氣象資訊往往是艱深難懂的知識。另一方面，各領域的氣象資訊需求存在極大的差異，且其要求的氣象資訊，甚至可能已超過目前的科學極限。因此，氣象資訊「提供者」及「需求者」之間需要有良好的溝通，了解彼此的能力及需求。對於氣象提供者而言，需從使用者角度出發，提供客製化服務，以期讓氣象資訊能更普及化、大眾化，發揮最大利益。為達到上述目的，氣象業務及氣象需求單位都需要先建立資料庫，透過大量資料的分析，找出氣象與其他產業之間的關聯性，再經過降尺度等技術，產製個別產業的客制化產品。這有賴於氣象業務單位與其他產業間良好的跨領域合作。

事實上,我國中央氣象局近幾年在氣象推廣方面著力甚深,除陸續辦了公衛、農業、漁業、水資源等 4 個領域的氣象資訊分享研討會，亦已對各農漁會、國小、地方氣象站等對象講解氣候資訊與應用。在中央氣象局的官網也有，如天氣小幫手、天氣週報等口語化的預報產品；在社群網路服務方面，亦陸續成立了報天氣、報氣候、報天文、Good Weather 古都好天氣-臺灣南區氣象中心粉絲專頁、SOS 地球科學展示系統粉絲團等，積極推廣氣象、氣候的科普常識與應用。

2015 年於法國巴黎的聯合國氣候高峰會(United Nations Climate Change Conference, COP 21)，做出要在 2100 年之前把全球暖化限制在+2°C 以內(相對於工業革命前)的協議,不久之後在 2018 年 10 月 8 日聯合國政府間氣候變化專門委員會(IPCC)又提出《全球升溫 1.5℃特別報告(Global Warming of 1.5℃)》，藉由暖化+1.5℃與+2℃的比較，說明若能將暖化由+2℃更限縮至+1.5℃，不僅能大幅降低氣候變遷帶來的重大衝擊，還能對人類和自然生態系統有明顯的益處。近年來，如何減緩與調適氣候變遷帶來的衝擊已成熱門議題，各國除投入大量的人力與經費於氣候的能力建設外，亦舉辦許多氣候變遷相關的研討會。

雖然中央氣象局近年已逐漸重視氣候的能力建設，但相對於其他國家還是稍顯不足。舉例來說，國力與臺灣相去不遠的韓國，在 2005 年就投入大量的資源成立 APCC。十多年過去了，目前 APCC 已成為可獨當一面，領導區域氣候發展的重要單位。猶如在研討會上許多專家所提到的，氣候研究的投資是長期性，短時間無法體會到投資氣候帶

來的益處，但就像典藏的陳年老酒一樣，當投資時間拉長，就能品嚐到愈陳愈香的氣候益處。

綜合本次參與此次研討會的心得，有 4 點建議如下：

(一)推動大眾化、客製化的氣象服務。

由於氣象資訊「提供者」及「需求者」之間可能存在許多認知上的差異，因此雙方需要有良好的溝通，了解彼此的能力及需求。對於氣象提供者而言，需從使用者角度出發，提供客製化服務，以期讓氣象資訊能更普及化、大眾化，發揮其最大利益。氣象業務單位與其他產務之間要有良好的跨領域合作

(二)持續維持國際合作，積極參與國際會議及課程。

鼓勵年輕同仁多與國際接觸，加強英語論述表達能力，出席會議時可代表中央氣象局發言，讓臺灣在國際場合上為與會者關注，並在國際上結交一些相互支持的伙伴，讓臺灣走出去並與國際接軌。

(三)長期投資氣候能力建設與服務。

氣候研究的投資是長期性，短時間無法立即呈現投資氣候能力建設所帶來的效益。然而，在氣候變遷之衝擊漸趨嚴重的現在與未來，提升氣候能力建設能夠同步提升短期氣候預報能力，進而強化氣候服務應用效能，達到氣候預警、減災之良好益處。

(四)各國都在做氣候服務

由此次研討會的主要議題及討論內容來看，與會各國都有從事氣候服務的工作，主要仍偏重對公衛、農、漁極端事件的早期預警系統方面的需求，尤其像霍亂、痢疾、登革熱等流行疫情的早期預警。同時也發現東南亞國家也有類似的氣候服務需求，或許我們可配合政府南向政策，對國家有拓展氣候服務的空間。

附錄 1：研討會議程(1/3)

Day 1: Tuesday, 20 August 2019

08:00 - 09:00	Registration (Location: Ground floor- University of Magallane)
09:00 – 09:30	**Opening Ceremony (Location: 1F Auditorium)**
09:00 – 09:05	Opening Remarks **Won-Tae Kwon**, Executive Director, APCC
09:05 – 09:10	Welcome Remarks **Juan Oyarzo Pérez,** President, University of Magallanes **Guillermo Navarro Schlotterbeck**, Director, Direccion Meteorologica de Chile
09:10 – 09:15	Congratulatory Address **José Fernández Dübrock,** Regional Governor of Magallanes
09:15 – 09:25	Commemorative Plaque Presentation
09:25 – 09:30	Group Photo
09:30 – 10:00	Coffee / Tea Break (Location: 1F)
10:00 – 12:30	**Keynote Session -** Climate Services for Sustainable Development under a Rapidly Changing Climate
10:00 – 10:30	Reflecting about Antarctica: their role in a changing planet **Marcelo Leppe**, Director, Chilean Antarctic Institute
10:30 – 11:00	Climatology in support of climate risk management **Glenn McGregor**, Professor, Department of Geography, Durham University
11:00 – 11:30	Climate services for health – realizing social impacts **Joy Shumake-Guillemot**, Officer in Charge, WHO-WMO Joint Office for Climate and Health, WMO
11:30 – 12:30	Wrap-up and Discussion
12:30 – 13:30	Lunch (Location: 1F)
13:30 – 12:30	**Session I -** Understanding of Extreme Climate Events and their Impacts
13:30 – 14:00	Global Infrastructure for Predicting Climate Variability and its Potential for Anticipating Changes in the Occurrence of Local Climate Extremes **Arun Kumar,** Principle Scientist, CPC/NCEP/NWS/NOAA
14:00 – 14:30	The Changing El Niño in the 21st Century: Properties, Dynamics, and Impact **Jin-Yi Yu**, Professor, University of California, Irvine
14:30 – 15:00	Forecasting of extreme weather events from sub-seasonal to decadal timescales **Paul Gregory**, Senior Prediction Scientist, Bureau of Meteorology
15:00 – 15:30	Coffee / Tea Break (Location: 1F)
15:30 – 16:00	Meteorological extreme events: From long-duration droughts to major floods **Jose Vicencio**, Meteorologist, Chilean Weather Service(DMC)
16:00 – 16:30	Global Change in the southern-austral region of Chile and its impact in future climate **Jorge Carrasco**, Research Associate, Antarctic Gaia Research Center

附錄 1：研討會議程(2/3)

16:30 – 17:30	Wrap-up and Discussion
18:00 – 20:00	Welcome Reception (Location: TBD)

Day 2: Wednesday, 21 August 2019

09:00 – 13:00	**Session II -** Innovating Early Warning System to Manage Impacts of Climate Extremes
09:00 – 09:30	Shifting Hazards and Early Warning for a Changing Climate **Tim Manning**, Senior Advisor, Pacific Disaster Center
09:30 – 10:00	Overcoming the creeping nature of drought by tracking invisible energy fluxes **Daeha Kim**, Research Fellow, APCC
10:00 – 10:30	Risk Information Integration and Dissemination for Extreme Events **Tzu-Yin Chang**, Chief team leader, APEC Research Center for Typhoon and Society, National Science and Technology Centre for Disaster Reduction
10:30 – 11:00	Coffee / Tea Break (Location: 1F)
11:00 – 11:30	The Warning System of Chilean National Weather Service **Paola Uribe**, Meteorologist, Chilean Weather Service(DMC)
11:30 – 12:00	How Early Is Early Warning of Climate Extremes **Ashbindu Singh**, President, Environmental Pulse Institute
12:00 – 13:00	Wrap-up and Discussion
13:00 – 14:00	Lunch (Location: 1F)
14:00 –	**Session III -** Connecting Climate Information to Socio-Economic Values
14:00 – 14:30	Tailoring climate information for better use : APCC's effort **Jinho Yoo,** Director of Climate Services and Research Division, APCC
14:30 – 15:00	Extreme weather early warning systems: bridging the climate science – health divide **Sally J Edwards**, Regional Advisor, Pan American Health Organization
15:00 – 15:30	Urban climate information at the service of planning and management of the environment and sustainable development of Latin American cities **Hugo Romero**, Professor, Department of Geography, University of Chile
15:30 – 16:00	Coffee / Tea Break (Location: 1F)
16:00 – 16:30	Grasslands monitoring in Magallanes, a tool for farm planning as a socio-economic benefit for the Region **Sergio Radic Schilling**, Director of Research, University of Magallanes
16:30 – 17:30	Economic Assessment of Hydro-Met Services and Products: A Value Chain Approach **Jeffrey Lazo,** Economist, Jeffrey K Lazo Consulting
17:30 – 18:30	Wrap-up and Discussion

附錄 1：研討會議程(3/3)

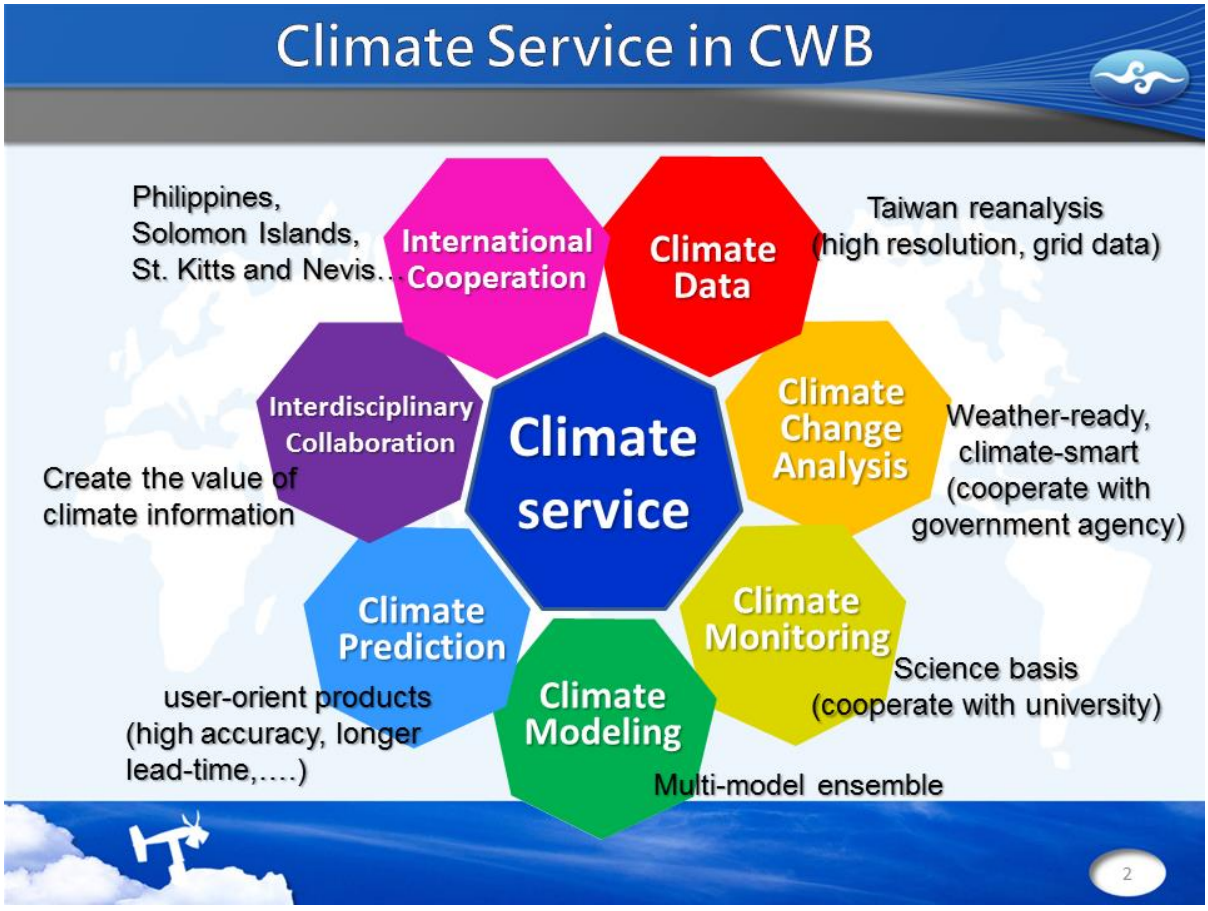
Day 3: Thursday, 22 August 2019

09:00 – 12:00	**Wrap-up**
09:00 – 09:20	**Session I - Understanding of Extreme Climate Events and their Impacts** **Seantae Kim**, Research Fellow, APEC Climate Center
09:20 – 09:40	**Session II - Innovating Early Warning System to Manage Impacts of Climate Extremes** **Boksoon Myoung**, Research Fellow, APEC Climate Center
09:40 – 10:00	**Session III - Connecting Climate Information to Socio-Economic Values** **Hugo Romero**, Professor, Department of Geography, University of Chile
10:00 – 10:30	Coffee / Tea Break (Location: 1F)
10:30 – 12:00	**Panel Discussion**
12:00 – 12:10	**Closing Ceremony (Location: 1F Auditorium)**
12:00 – 12:05	Closing Remarks **Guillermo Navarro Schlotterbeck**, Director, Direccion Meteorologica de Chile
12:05 – 12:10	**Won-Tae Kwon**, Executive Director, APCC
12:10 – 13:00	Lunch (Location: 1F)
13:00 – 18:00 (TBD)	**Technical tour to Fuerte Bulnes (TBD)**

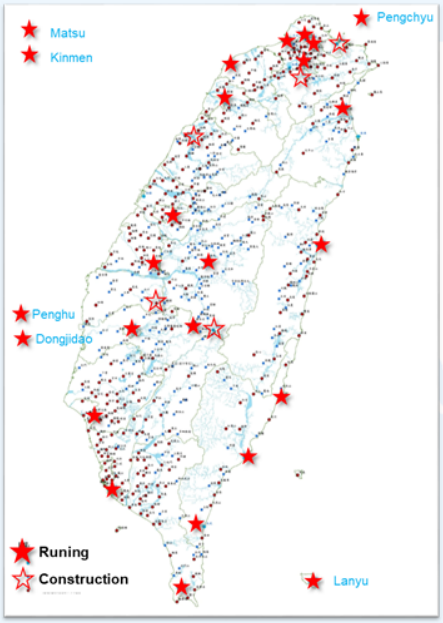
附錄 2：APCC 工作小組設定議程

TIME	AGENDA
10:00 - 10:05	Opening by Dr. Enrique Garrido Segovia (Chile)
10:05 - 10:15	Self-Introduction to the participants (by each participant)
10:15 - 10:30	**Presentation** 2019 APCC Status (by Dr. Jin ho Yoo, APCC)
10:30 - 11:00	**Presentation** Sharing the current status and future plan of climate prediction and services of NHMSs * Presentation: Japan, New Zealand, Papua New Guinea, Chinese Taipei
11:00 - 12:00	**Discussion** Possible collaborations between Members including APCC, to improve climate predictions and climate services 1. *Seasonal and sub-seasonal forecast (S2S)* To know the state of progress in this topic in the Asia-Pacific region and to visualize possible cooperation between countries and with the APCC, in methodological aspects for the elaboration and mainly to share the experience of diffusion and the level of utility in the different productive sectors in countries. 2. *ENSO phenomenon and its impact on the Asia Pacific region* Discuss among the participants the observed behavior of the El Niño / La Niña Phenomenon, which is presented with important variations, especially on the coast of Chile, where the relationship with the rain / drought no longer seems so good. Know if this behavior is generalized in the region, or is only limited to certain areas. 3. *Climate Services* To know the experience of the members and the state of progress of the countries, in the issues related to the implementation of a National Framework of Climate Services (NFCS). Identify ways in which cooperation and assistance among members can be encouraged, including the APCC. 4. *Form cooperation in the region* Identify what would be the best forms of cooperation and financing among members and with the APCC, to help countries be better prepared against the threats of climate change.

附錄 3：林主任秘書在 APCC 工作小組的簡報



Introduction of Climatic Observation



Overview of Weather Observations in CWB

- **26 Climatic Observation Stations (★)**
  - 5 stations under construction (☆)
- **532 Automatic Stations**
  - 385 automatic weather stations (2017)
  - 147 automatic rain stations (2017)
- **3 Upper-air Stations**
  - Taipei (including Ozonesonde), Hualien and Dongsha (cooperated with Navy)
- **1 Atmospheric Background Station** (Lanyu island)
- **2 BSRN Radiation Stations** (Lanyu island and Mt. Yushan)
- **2 Total Ozone observation stations** (Taipei and Chenggong)
- **34 UV stations**
- **19 Lightning Detecting Sites**

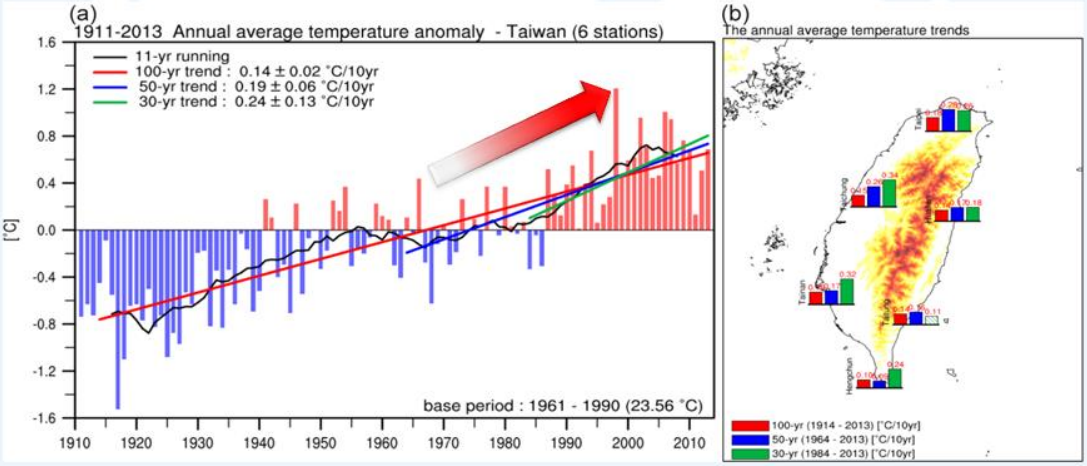
Automatic Climate Observation System (ACOS)

- **Background**
  - System design are referred to **U.S. Climate Reference Network(USCRN)**, and designed in multi-module and IP-Based sensors.
- **Benefit**
  - Multi-module sensors can be reduced the risk of missing data due to the breakdown, induced the reliability of the system
  - IP-Based sensors can be controlled and maintained remotely via network system to improve the efficacy in data transportation and processing (like IoT)
  - Upgrade data sampling frequency, storage and quality control interval

Climate Service in CWB

Climate Change Analysis

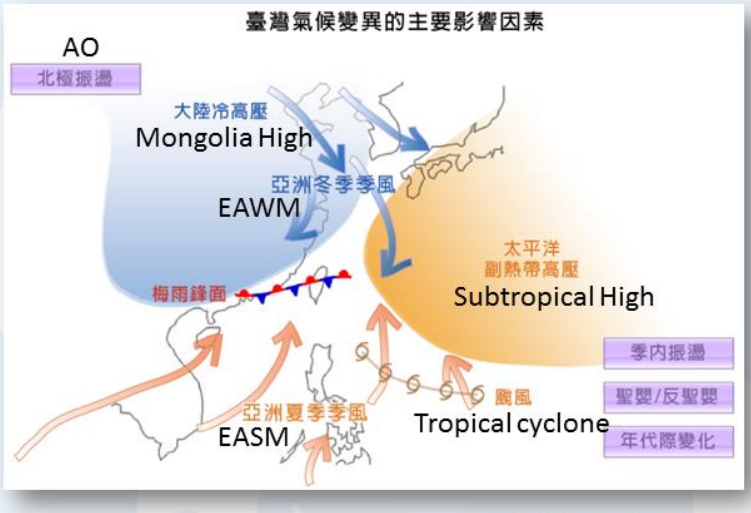
- Understand the past climate change of Taiwan
- Provide the information of climate change for government agencies to make national climate change adaption policies.

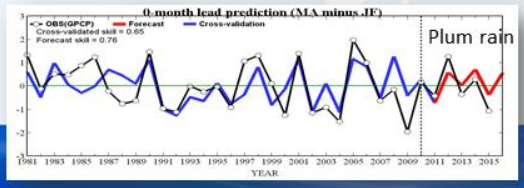


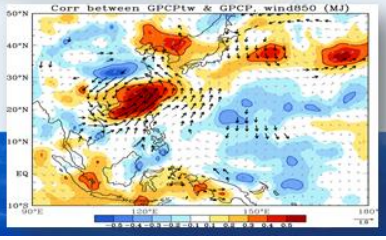
Climate Service in CWB

Climate Monitoring

- Understand the mechanism of large-scale phenomena acting on Taiwan to develop forecast guidance
  - EASM/EAWM
  - MJO/BSISO/ISV
  - ENSO/IOD
  - AO/PDO/AMO



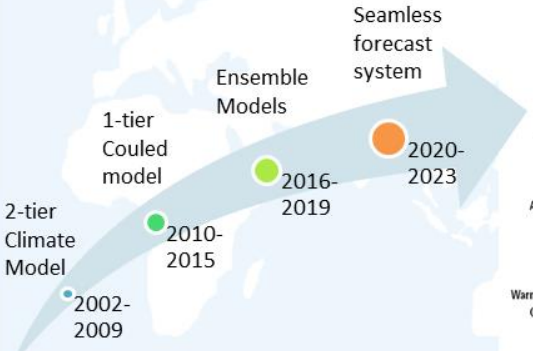


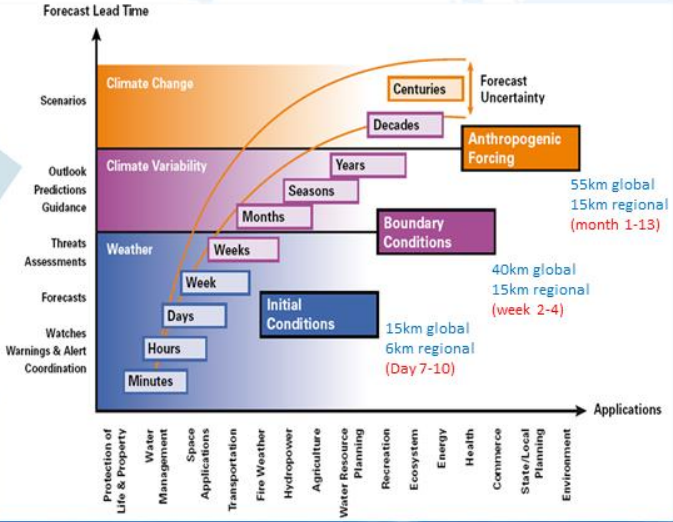


Climate Service in CWB

Climate Modeling

- Upgrade global coupled model with new ocean model
- Raise the skill of sub-seasonal to seasonal forecasts to provide user-oriented climate service

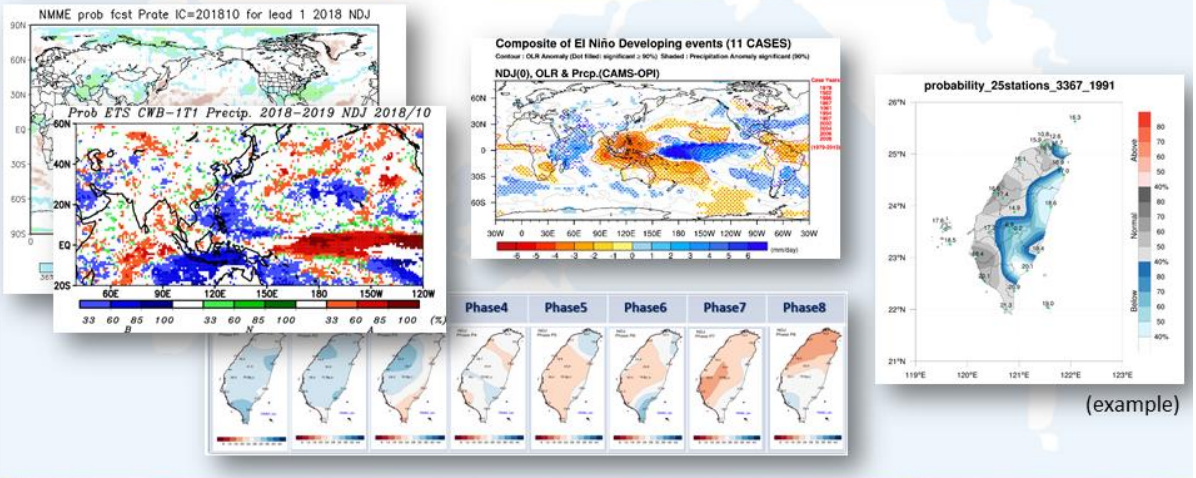




Climate Prediction

Forecast guidance development

Model development → Post-process → Forecast guidance



(example)

Climate Products History

Monthly Outlook (Old)

- Next three 10-days
- Issued twice a month from 1989

and Precipitation (right panel; unit:%)

R	1st week (Apr27-May3)	2nd week (May4-May10)	4 weeks (Apr27-May24)
	Below Normal Above	Below Normal Above	Below Normal Above
N	10 : 60 : 30	30 : 50 : 20	30 : 50 : 20
C	0 : 40 : 60	30 : 50 : 20	30 : 50 : 20
S	0 : 40 : 60	0 : 70 : 30	20 : 50 : 30
E	10 : 60 : 30	30 : 50 : 20	30 : 50 : 20

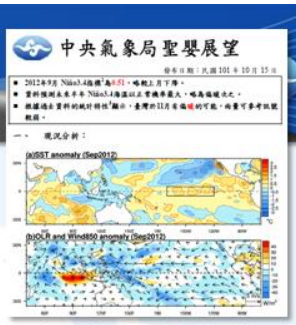
g Taipei, Taichung, Kaohsiung, and Hualien, respectively as the

unit:℃) and Precipitation (right panel; unit:mm)

R	1st week (Apr27-May3)	2nd week (May4-May10)	4 weeks (Apr27-May24)
N	11.0～59.0	8.9～45.5	116.3～216.0
C	1.5～43.6	1.4～44.7	103.1～201.7
S	0.0～20.3	0.0～19.5	66.0～137.4
E	11.2～33.2	6.2～30.0	85.5～188.1

Monthly Outlook (New)

- Next four weeks
- Issued weekly
- Probability form
- English version from 2006



ENSO Outlook

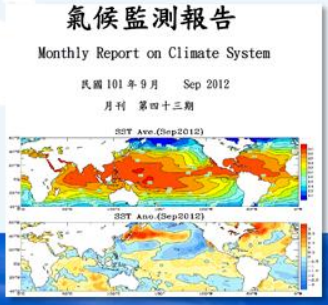
Statistical (1995-2007) — *CWB 1-T (2010-2015)*

1979 — 1994 — 2005 — 2010 — 2014

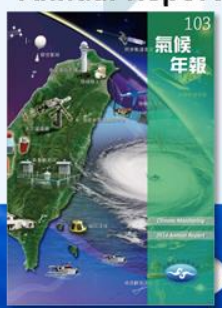
CWB 2-T CFS (2002-2009)

Seasonal Outlook

- Next three month
- Issued monthly
- Probability form from 1999
- Colorful version from 2009



Annual Report



Climate Prediction

Product dissemination

9

Climate Prediction

Forecast application

- Feb — Spring rain outlook
- Apr — Plum rain outlook
- Jun — TC outlook
- Aug — Autumn outlook
- Nov — Winter outlook
- Dec — Global warming

10

Interdisciplinary Collaboration

Platform for Cross-sector Weather Applications

Cooperation across agriculture, fishery, transportation, health, and energy sectors with emphasis on local characteristics

氣象跨域應用平台
CroWA Cross-sector Weather Applications

https://crowa.cwb.gov.tw/

Interdisciplinary Collaboration

Farm

Rice cultivation calendar

Workshop for Farmers

Interdisciplinary Collaboration

Fishery

Platform for Cross-sector Weather Applications

General Search

- Severe Weather Advisories
- Cloud Image
- Radar Image

Fishery Advanced Search

- Cold Surge Warning
- Fishing Port Sea Conditions
- Marine Aquaculture Sea Conditions
- Taipei Flight Information Region Sea Conditions
- Land-based Aquaculture Weather

Fishery Group Management

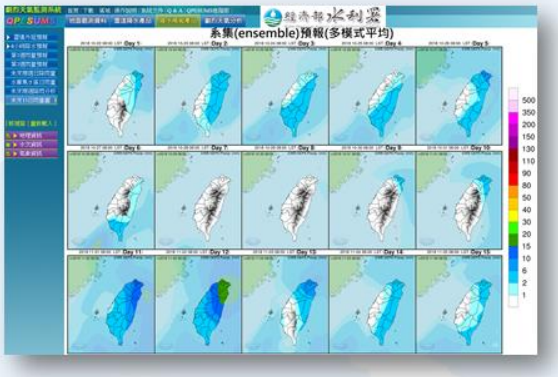
- Announcements
- Land-based Aquaculture Management
- Map Settings
- Member Management
- Advanced Settings

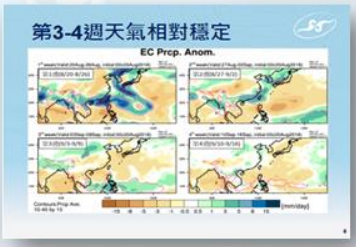
13

Interdisciplinary Collaboration

Water Resource Agency

- Provide seamless forecasts (1-3-6 hrs, 15days, week 1&2) through customized system
- Provide 2nd season outlook (especially spring rainfall) for water resource management
- Provide seamless forecasts (from 7-day weather to 2nd season) for drought prevention and adaptation





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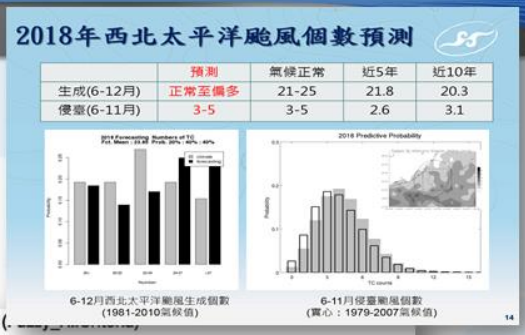
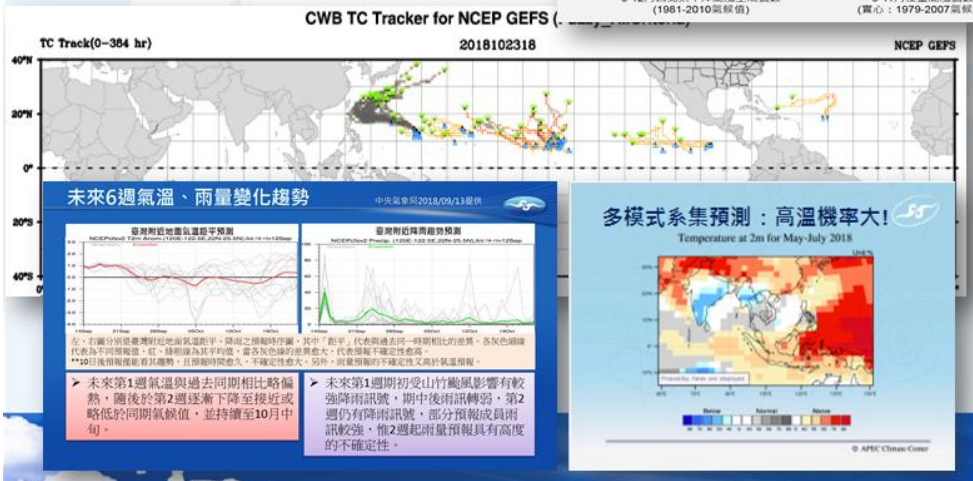
Interdisciplinary Collaboration

Taiwan Power Company

- Provide TC seasonal forecasts for hydroelectric power management
- Provide TC track forecasts for natural gas import
- Provide week3-6 forecasts (heat wave outlook) for power dispatch





15

Interdisciplinary Collaboration

Green Energy Development

● Cooperation with Bureau of Energy(BOE)(2017-2020)

CWB

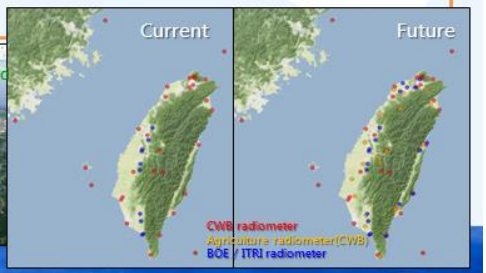
	Green Energy Forecasting System	Green Energy Assessment and Optimization System	Green Energy Monitoring System
Product	Provide forecast data ,included 100 m wind velocity/ 100 m wind power/ 100 m Wind energy density/Solar shortwave radiation /solar power	Provide history monthly, seasonal, annual average data , included 100 m wind velocity/ 100 m wind power/ 100 m Wind energy density/Solar shortwave radiation /solar power	**Provide monitoring data**, included 100 m wind velocity/ 100 m wind power/ 100 m Wind energy density/Solar shortwave radiation /solar power
Resolution	2km→0.25km	1km→ 0.5km	3km→ 0.5km

Establish Meteorological-information Based Green Energy Operation Center

Construct exchange platform for the data of CWB and BOE

BOE

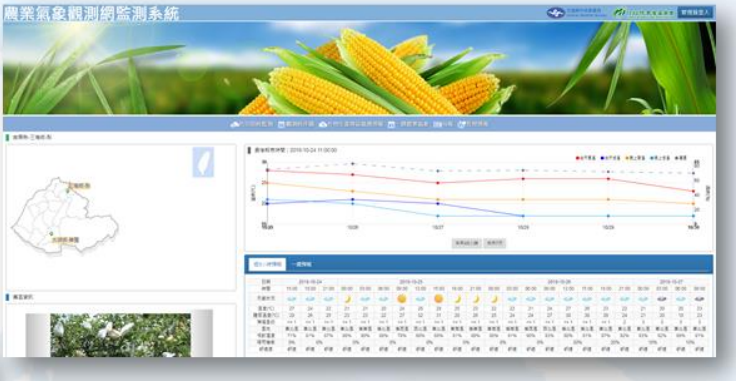
- Offshore wind farm power generation evaluation display system
- Establish a full sky radiometer monitoring system
- Establish a solar photovoltaic power generation estimation model
- Ship dispatching and tracking decision system of Offshore wind turbine construction
- Development of a pyranometer sample with adjustable spectral response (PERC RC)

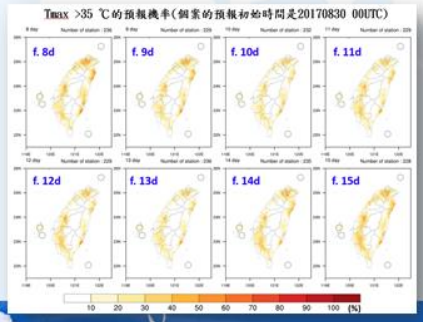


Interdisciplinary Collaboration

Council of Agriculture

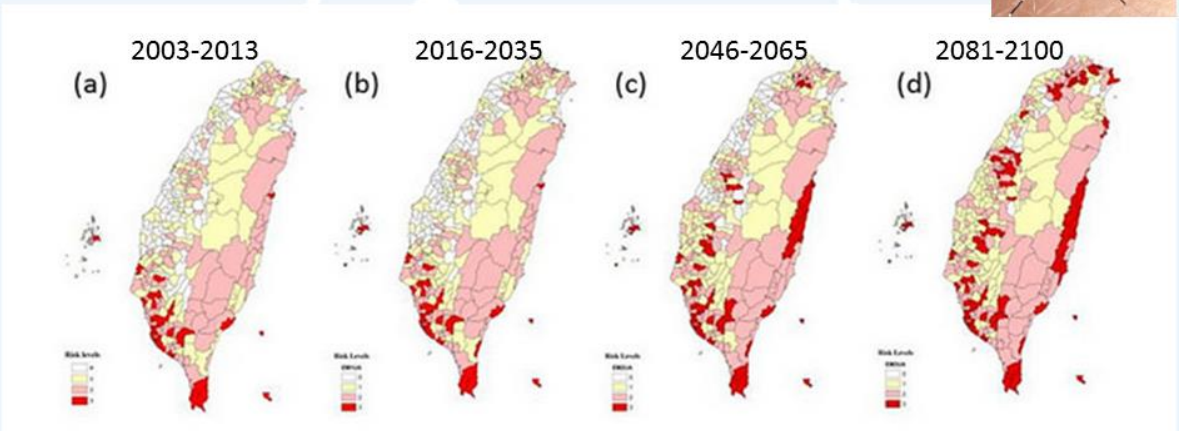
- Provide spring rainfall outlook for rice planting
- Provide 7-day township forecasts for agricultural products planting
- Plan to provide extreme event probability (experimental)





Interdisciplinary Collaboration

Public Health, the risk of dengue



Increasing risk of the dengue under global warming (RCP8.5 scenario)

From Taiwan Climate Change Projection and Information Platform (TCCIP)

Interdisciplinary Collaboration

Heat wave and public heath

Cardiovascular

Respiratory

14 heat waves composite

(Wu et al. Occupational and Environmental Medicine, 2010)

14 個熱浪事件前後心臟血管疾病死亡比

14個熱浪事件前後呼吸道疾病死亡比

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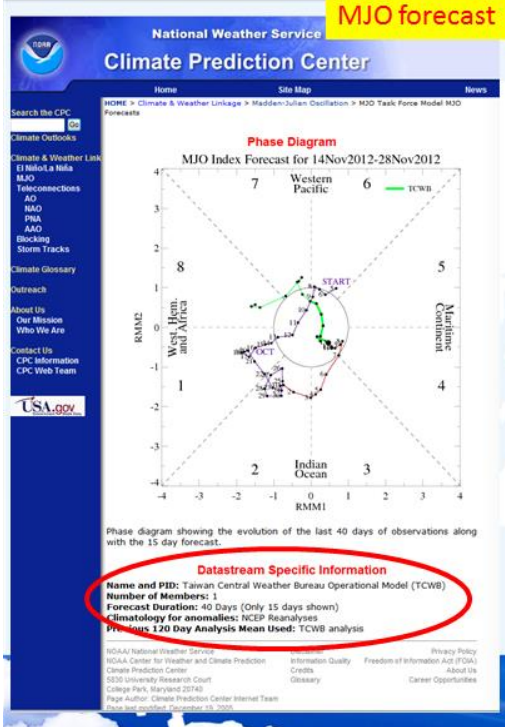
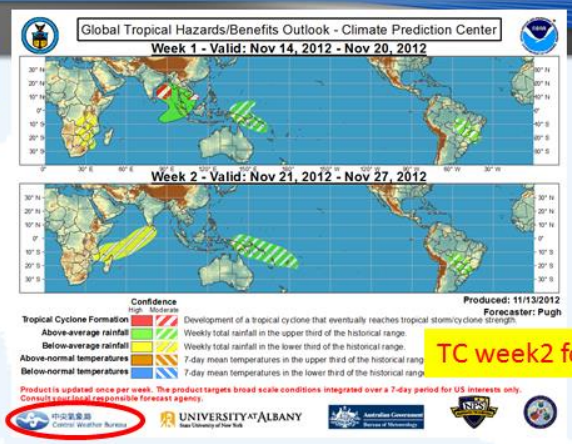
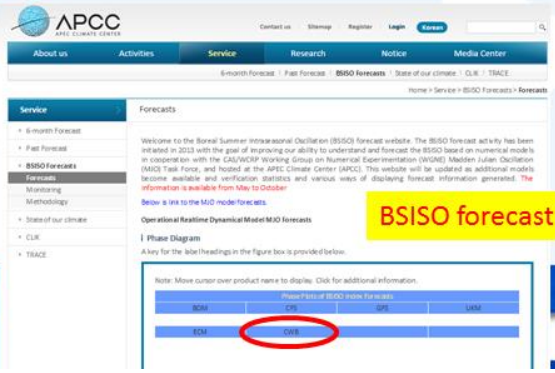
International Cooperation

MJO forecast





TC week2 forecast

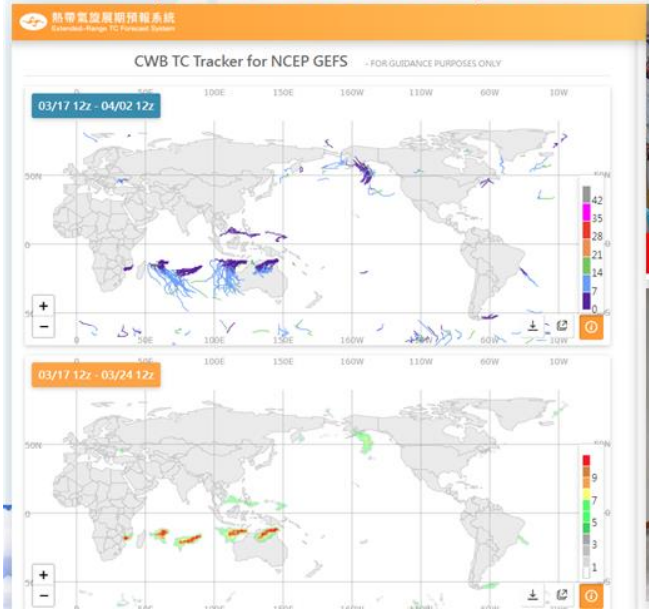


BSISO forecast

International Cooperation

Philippines

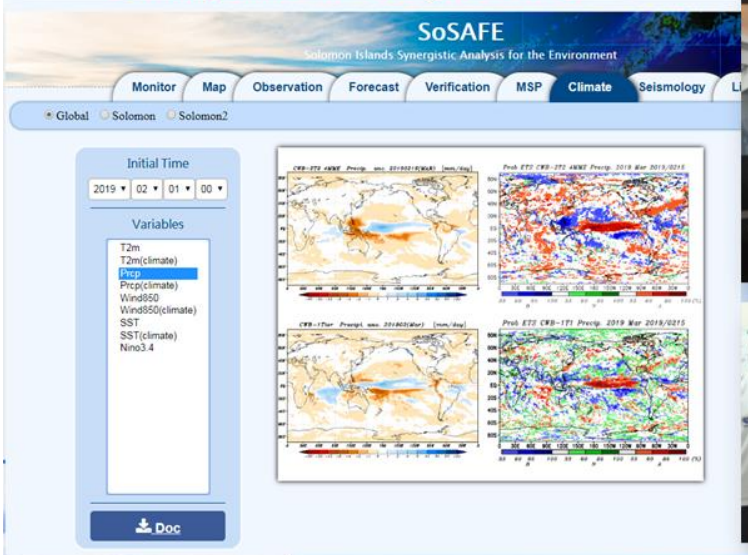
- VOTE project - Typhoon formation, structure, and intensity change in western NP and wave observation and modeling
- Improvement of threat potential forecast and climate service.



International Cooperation

Solomon Islands

- Solomon islands meteorology and earthquake early warning system project
- Establish a multi-hazard early warning system for heavy rainfall, earthquake and dengue fever.



International Cooperation

St. Kitts and Nevis

- Capability building of adaptation to climate change on agriculture in St. Kitts and Nevis





23

International Workshop

2019 International Workshop on Climate Prediction

CWB co-hosted with APCC
June 3-4, 2019 in Taipei

total 39 Speakers, around 100 attendees.

Next workshop:
28-29 Oct. 2019, Taipei
Asia Pacific Climate Service Workshop

Session 1
Tell Your Story – Climate Service Development
Session 2
Climate Product and Assessment
Session 3
Climate Communications and Management

Welcome !!

Climate Service in CWB

Provide science based Climate Service/information to responsible departments and civilian societies for safer and better lives.

Collaboration is unlimited

25

附件4: working group meeting 會議記錄

APCC Working Group Meeting 2019

Date & Time: 22 August 2019, 10:00 – 12:30

Location: #316, Teaching and Research Assistance Center (CADI), University of Magallanes

Participants

Chairperson: Dr. Enrique Garrido Segovia (Deputy Director, National Weather Service of Chile, Chile

Members: Dr. Paul Gregory (Senior Prediction Scientist, Bureau of Meteorology, Australia)

Mr. Muhammad Agung Fauzi (Head of Sub Division for Environment Climate Information, Applied Climate Information Services Center, Agency for Meteorology Climatology and Geophysics, Indonesia)

Mr. Takayuki Tokuhiro (Senior Coordinator for Climate Modeling, Japan Meteorological Agency, Japan)

Ms. Khazainani Salleh (Director, National Climate Centre, Malaysian Meteorological Department, Malaysia)

Dr. Brett Mullan (Principal Scientist, National Institute of Water and Atmospheric Research, New Zealand)

Mr. Kasis Inape (Assistant Director of Climate and Special Services, National Weather Service, Papua New Guinea)

Mr. Gustavo De La Cruz Montalvo (Climate Specialist, Department of Meteorology and Atmospheric Environment Assessment, National Service of Meteorology and Hydrology, Peru)

Ms. Rosalina De Guzman (Assistant Weather Services Chief, Climate and Agrometeorology Division, Philippine Atmospheric, Geophysical & Astronomical Services Administration, the Philippines)

Dr. Yeu-Woo Lin (Chief Secretary, Central Weather Bureau, Chinese Taipei)

Mr. Maytee Mahayosanunta (Director of Weather Forecasting Division, Thai Meteorological Department, Thailand)

Mr. Le Thanh Hai (Vice Administrator, Viet Nam Meteorological and Hydrological Administration, Vietnam)

APCC: Dr. Won-Tae Kwon (Executive Director)

Dr. Jin-Ho Yoo (Director of Climate Services and Research Division)

Ms. Sangwon Moon (Acting Director of Operations Division & Head of External Affairs Department)

Ms. Suhee Han (External Affairs Department)

Observer: Mr. Gaston Torres (Deputy Director, National Weather Service of Chile, Chile)

Dr. Ming-Ying Lee (Associate Technical Specialist, Research and Development Center, Central Weather Bureau, Chinese Taipei)

Agenda

TIME	AGENDA
10:00 – 10:05	Opening by Dr. Enrique Garrido Segovia (Chile)
10:05 – 10:15	Introduction of the participants (by each participant)
10:15 – 10:30	**Presentation** 2019 APCC Status (by Dr. Jinho Yoo, APCC)
10:30 – 11:20	**Presentation** Sharing the current status and future plan of climate prediction and services of NHMSs * Presentation: Japan, New Zealand, Papua New Guinea, Chinese Taipei
11:20 – 12:30	**Discussion** Possible collaborations among members including APCC, to improve climate predictions and climate services *1. Seasonal and sub-seasonal forecast (S2S)* - To know the state of progress in this topic in the Asia-Pacific region; - To visualize possible cooperation among economies and with APCC, in methodological aspects for the collaboration; - To share the experiences of diffusion and the level of utility in the different sectors in economies *2. ENSO phenomenon and its impact on the Asia Pacific region* -To discuss among participants the observed behavior of the El Niño / La Niña Phenomenon, which is presented with important variations, especially on the coast of Chile, where the relationship with the rain / drought no longer seems so good - To know if this behavior is generalized in the region, or is only limited to certain areas *3. Climate Services* - To know the experience of the members and the state of progress of the economies, in the issues related to the implementation of a National Framework of Climate Services (NFCS) - to identify ways in which cooperation and assistance among members can be encouraged including APCC *4. Cooperation in the region* - To identify what would be the best forms of cooperation among members and with APCC, to help economies be better prepared against the threats of climate change

Meeting Minutes

1. Opening & Participants Introduction

Dr. Enrique Garrido Segovia, Chair of the APCC Working Group (WG) Meeting 2019, started the meeting by welcoming all participants to Punta Arenas, Chile.

Then, he asked each member for self-introduction. Dr. Won-Tae Kwon, Executive Director of APCC greeted members as well with sincere appreciation of participation.

The participants of the meeting introduced themselves. Mr. Le Thanh Hai, Vice Administrator of Viet Nam Meteorology and Hydrology Administration (VMHA), thanked APCC for providing seasonal and sub-seasonal climate information. Mr. Maytee Mahayosanunta, Director of Weather Forecasting Division of Thai Meteorological Department (TMD), introduced himself and mentioned the recent dryness over the economy which affected especially agriculture sector. He pointed out the importance of this meeting and expressed his expectations on sharing good ideas of cooperation. Dr. Yeu-Woo Lin, Chief Secretary of the Central Weather Bureau in Chinese Taipei (CWB), stated his appreciation for APCC and the National Weather Service of Chile (DMC) for providing an opportunity to learn from other members including APCC and share his experiences. Dr. Ming-Ying Lee from the Central Weather Bureau introduced himself with interests in long-range forecast and climate monitoring and research. Ms. Rosalina De Guzman, Assistant Weather Service Chief from the Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA), explained unavailable status of Dr. Flaviana Hilario's travel outside of the Philippines due to her retirement in next January. She also mentioned that this meeting is a good opportunity for PAGASA to exchange ideas relating common interests such as ENSO and PAGASAhoped for collaborations among members and APCC in terms of capacity building. Mr. Gustave De La Cruz Montalvo, Climate Specialist at the department of Meteorology and Atmospheric Environment Assessment from National Service of Meteorology and Hydrology (SENAMHI), Peru, also recognized the importance of the meeting and sharing experiences especially related with climate change and El Nino. He explained that Peru experienced influenza pandemic due to El Nino, also climate change has been greatly affecting Peru. He highlighted that this opportunity would contribute to developing climate forecast and projection in Peru as well as member organizations. Mr. Kasis Inape, Assistant Director of Climate Services from the PNG National Weather Service (NWS), stated that he was participating the meeting on behalf of Mr. Samuel Maiha, Director of PNG NWS and appreciated the opportunity for participating in the meeting. He expressed his willingness to learn from other members since the members share common issues and interests in the region and he would like to draw attention on supports to PNG from members and APCC. Dr. Brett Mullan, Principal Scientist from the National Institute of Water and Atmospheric Research (NIWA), stated that NIWA has separated research and operation of meteorological services and that broad focus of NIWA lies on environmental issues such as flooding and droughts. He also expressed his interest in climate forecast. Mr. Takayuki Tokuhiro, Senior Coordinator for Climate Modeling of the Japan Meteorological Agency (JMA), introduced himself as a new representative of JMA to APCC WG and his interest lies on developing climate models. Mr. Muhammad

Agung Fauzi, Head of Sub-division for Environment Climate Information from the Indonesian Agency for Meteorology Climatology and Geophysics (BMKG), expressed his interests in how to develop the climate information based on the impacts, and cooperation with other application sectors. Mr, Gaston Torres, Deputy Director of the National Weather Service of Chile (DMC), appreciated the group for allowing his participation as an obsever, and highlighted the importance of climate services and its implementation in climate change. Dr. Paul Gregory, Senior Prediction Scientist from the Australian Bureau of Meteorology (BOM), introduced himself as a person in charge of developing extreme prediction in seasonal and sub-seasonal time scale, and he agreed that ENSO and climate change greatly affect the region. Ms. Khazainani Salleh introduced herself as Director of National Climate Center in Malaysian Meteorological Department (MetMalaysia), and informed that Dr. Alui Bahari who was a former WG member of APCC from Met Malaysia retired from the organization and she participated this meeting on behalf of a Met Malaysia representative.

2. Presentations

2.1. APCC – Dr. Jin Ho Yoo (Director of Climate Services and Research Division, APCC)

Dr. Enrique Garrido Segovia, Chair of the meeting, appreciated all the members for the introduction. He stated that the region has common issues and therefore there would be more and better cooperative opportunities among members. Then, he invited Dr. Jin Ho Yoo, a Director of Climate Services and Research Division of the APEC Climate Center, to present the APCC's status on 2019.

Dr. Jin Ho Yoo thanked the members for participating the meeting once again and stated that this group has been evolved as a good form of collaboration every year. Then, he began his presentation by introducing the changes in APCC's strategic direction and related activities; in the past, APCC provided climate information with multi-model ensemble (MME) prediction system using APCC in-house model, Seamless Coupled Prediction System (SCoPS), and intraseasonal oscillation (ISO) forecast information, in one hand, and, on the other hand, APCC conducted researches on climate application parts such as water resources, agriculture, and disaster management. These two parts were connected by tailoring and feedback mechanism and also connected with capacity building activities. Now, the APCC activities are more focusing on climate prediction part, the essential mandate requested by APEC economies when APCC was established. This new direction has been strategically set to better serve NMHSs and related organizations in the APEC region and beyond including Republic of Korea by advancing APCC's prediction skills and related methodologies. Also, APCC more focuses on supporting the climate prediction of the Republic of Korea. Given the new strategy and related finance changes, APCC could not host any capacity building activities in 2019 and it is anticipated that the situation would be similar for the next year as well. In the meantime, Dr. Yoo mentioned that co-host or collaboration opportunities for capacity building activities could be possible options.

Dr. Yoo explained the recent changes of APCC's organizational structure of 2 divisions; the Climate Services and Research Division and the Operations Division. There are 3 departments under Climate Services and Research Division; the Climate Prediction Department, the Climate Analytics Department, and the Prediction Research Department. And there are 2 departments under Operations Division; the External Affairs Department and the Administration Department. Now APCC has 67 staff, which is 11% reduced employers from the previous year.

Then, he introduced the improvement of APCC MME prediction system based on the hindcast and real-time forecast analysis. APCC MME prediction system has been improved in terms of the diversity of model composition. Also, 80% of the current participating models of APCC MME prediction systems are coupled models. Then, he explained the hindcast skill has been significantly increased in 2018 in comparison with the one in 2008 both in temperature and precipitation. All these results indicated that APCC MME prediction system has been collectively improved in last 10 years. In the meantime, real-time forecast shows similar result comparing to the past forecast skills. This is due to the fact that the skill is mostly dependent on ENSO or due to the global warming signal. If the climatology is changed to the recent periods, the real-time forecast would show skill improvement)

The comparison among global MME groups was conducted for T2M for global, East Asia, and North America. The global skills of global temperature in APCC and WMO MMEs are quite comparable while NMME shows slightly lower skill than other two groups. Overall, APCC MME shows comparable to or slightly higher skill than other two MME groups. Dr. Yoo stated that the efficiency of MME prediction comes from the model diversity and APCC has good collaborative links with individual model producing organizations.

Also, APCC has been providing APCC Climate Outlook every month with information on climate monitoring and prediction. Recently, APCC changed its structure for more formal and easy-to-read form with suggestions and comments from APCC Working Group including El Nino phase and trends. This is one of the APCC activities to improve its basic products.

Dr. Yoo, then, introduced the APCC's on-going research development. He explained that APCC is developing a regional MME prediction system for seasonal climate forecast. This includes combining selected models with different weights for specific region. APCC is now working on model performance, observed relationships for post-processing, and observation-model correspondence. In addition, APCC will develop guidelines on how to combine the models for a specific region. An example is PICASO – Pacific Initiative for Climate Application and Prediction Services, where combining dynamical and statistical models to improve forecast skills in a specific region.

APCC is providing subseasonal forecast information, mainly with Boreal Summer Intraseasonal Oscillation (BSISO) indices forecast. Related on-going research is how to utilize dynamical model prediction and this includes assessment of GCM's forecast skill, finding window of opportunity, and post-processing of forecast by machine learning. Dr. Yoo showed the artic oscillation graph and explained that multi-model ensemble proves better

skills in general time scale indicating the possibility of operations.

Since current BSISO information is difficult to understand, APCC is now trying to develop the methodology for BSISO response based on index and change the result map for better application and understanding. This new information will be available by early next year.

With regard to APCC's climate information services, Dr. Yoo explained that APCC is now working on moving climate information services in one platform with combining similar functions from various APCC climate information services such as ADSS (APCC Data Service System), CLIPS (Climate Information Processing System), OpenWPS (Open Web Processing Services), CLIK (Climate Information Toolkit), and AIMS (APCC Integrated Modeling Solution).

For outreach and projects, APCC has conducted training and collaboration with PAGASA in the Philippines and Sri Lanka Meteorological Agency with self-funding from each organization, and will soon conduct another in-country training workshop on CLIK in Santiago, Chile right after APCS 2019. Also, there are a couple of international projects with GCF (Global Climate Fund) and FAO (Food and Agriculture Organization).

Finally, Dr. Yoo summarized the issues raised during APCC Working Group meeting 2018. As to the early release of APCC MME forecast outlook, APCC is preparing the prediction system to send the information on the 20th of every month in this year. In the meantime, based on the individual request from WG members, APCC would also be able to send the preliminary climate prediction information soon. The second issue was regarding trainings on sectoral applications, and he explained that, due to the strategy change of APCC activities and funding issue, APCC is not able to conduct any training with own fund. In order to increase APCC's part in Training, APCC now is looking for other funding opportunities such as APEC, APN, etc.

2.2. JMA – Mr. Takayuki Tokuhiro (Senior Coordinator for Climate Modeling)

Dr. Enrique Garrido Segovia, the Chair of the meeting, invited for member presentations starting from JMA.

Firstly, Mr. Takayuki Tokuhiro from the Japan Meteorological Agency presented on the introduction of the Tokyo Climate Center (TCC) and its services.

Mr. Tokuhiro explained that TCC has served as a WMO Regional Climate Centre in the RA (Regional Association) II since 2009 and supports National Meteorological and Hydrological Services (NHMSs) through data and information provision and capacity development activities.

As a part of TCC's capacity developing activity in its role as RCC, TCC holds annual training seminars on the application of its climate monitoring and prediction products. The TCC training theme depends on TCC's technical advances each year and the last year training

theme was on one-month forecast.

Also, Mr. Tokuhiro introduced the TCC expert visit program. The program aims to share current status of climate services in each economy, to collect feedback, and to discuss possible future collaboration and cooperation with TCC. He then showed a map to indicate the participating economies and the years of expert visits.

TCC also provides a variety of monitoring and forecast products: monitoring of extreme climate events, climate database, long-term reanalysis data, interactive tool for analysis of the climate system, El Nino outlook, global average surface temperature anomalies, sub-seasonal and seasonal prediction products, and EFI-based climate early warning products. Especially regarding seasonal prediction products of TCC, he stated that JMA was designated as a WMO World Meteorological Centre (WMC) in 2017, and, as a part of its activities, the Centre conducts global numerical long-range prediction (GPC-LRF). The seasonal prediction products such as forecast maps, verification results, and gridded data are available from TCC website.

He also provided a comparison of current and future plan for binary gridded data, and by 2020, JMA will provide 6-month lead forecast data with 13 ensemble members in every 5 days.

Mr. Tokuhiro, then, added the 'monthly discussion on seasonal climate outlook', which is intended to assist NHMSs in the Asia-Pacific region in interpreting JMA's seasonal prediction products. This is issued every month around the 25th. He highlighted that TCC provides materials to NHMSs for making their own seasonal outlook, and if necessary, TCC would improve the materials based on the feedback from NHMSs.

2.3. NIWA – Dr. Brett Mullan (Principal Scientist)

Chair thanked JMA for the presentation and invited NIWA for the next presentation on current status and future plans for climate prediction and services in NIWA.

Dr. Brett Mullan from the National Institute of Water and Atmospheric Research (NIWA) firstly introduced the 4 parts in numerical weather prediction scale that NIWA has involved in: weather hazards, river hazards, floodplain hazards, and coastal hazards. He also provided an example as bridging the research, EcoConnect, an operational service for accessing environmental forecasts and information. It provides 1 km of high resolution data for commercial use.

Dr. Mullan introduced NIWA's products such as couple model flood forecasting that can be used for example in agriculture sector, seasonal timescale information for irrigation as Irrigation Insight, and pasture growth forecasts. He also introduced NIWA's activity on drought monitoring, prediction, and climate change research showing that drought in New Zealand would be severe according to the climate change scenario. NIWA is also working on high resolution ocean modeling. Unfortunately, the model does not provide good skills over New Zealand so as APCC information, as he added.

Then, Dr. Mullan shared the current state of seasonal climate forecasting of NIWA. The Seasonal Climate Outlook of NIWA includes temperature, rainfall, soil moisture, and river flows for 6 regions for the next 3 months and probability (%) forecasts provides the most likely outcome for each variables such as temperature and rainfall. The prediction information is derived from global climate models, a few in-house statistical models, and forecaster consensus. And the accuracy of the prediction information has increased in recent years as shown from the accuracy variability for temperature and rain forecasts graphs. From the graph, he also mentioned that the prediction skills in summertime show very low skill in general. NIWA also identified the climate drivers for New Zealand as El Niño and La Niña, Indian Ocean Dipole, Madden-Julian Oscillation, Status of the Tasman Sean, and Southern Annular Mode in order to enhance the predictability. He, then, showed a table for seasonal outlooks issued by other organizations over New Zealand and pointed out the APCC Climate Outlook indicates hotter state in 4 regions out of 6 New Zealand regions as other outlooks also show above normal temperature anomalies in many cases. He interpreted that is likely to be due to climate change as Dr. Jin Ho Yoo mentioned in his presentation.

There are limitations in NIWA's seasonal climate outlooks, as Dr. Mullan stated. Relatively coarse spatial resolution (70 km in horizontal resolution) is one of them as well as the difficulty of providing reliable prediction due to complex topography of New Zealand especially in terms of rainfall. It does not provide climate information as specific scales needed such as district or catchment level. However, it has comparably reasonable accuracy at large-scales in sea surface temperature and global or regional circulation.

In order to improve forecasts, NIWA allocated recent funds to downscale seasonal climate forecasts by machine learning (ML). The idea is to leverage recent advances in machine learning to develop models that learn to associate large-scale climate states as forecast by GCMs to observed local climate variables. With this effort, it is expected to develop new products that are more tailored to the needs of potential end-users in a level of a site, catchment, or region. In the process, main scientific components are GCMs validation, dimensionality reduction, autoML/hyperparameters tuning, and ensemble learning. Dr. Mullan also highlighted that NIWA is trying to directly forecast followings: number of days with zero rainfall, number of days with temperature exceeding 25℃, the probability that there will be more than *N* days exceeding 25℃, the probability that there will be a 'drought', and the probability of cumulative rainfall exceeding *N* mm.

Dr. Mullan also introduced the Climate Early Warning System (CLEWS) for the Pacific region. This project is currently to engage 7 economies in the Pacific and archive data in the center of each economy while New Zealand stores backup. The project aims to bring data together and manage them from many difference sources, to use all climate observations in near real time for risk management, and to meet the needs of Pacific stakeholders by providing simple yet scientifically sound climate products. He also pointed out the importance of the usability of products and stated that CLEWS products can begin to answer questions such as how to manage water levels in a dam, how many sunshine hours available for solar power systems, when is the threshold for crop loss met due to drought or heavy

rainfall, and what are the key impacts of the current and future climate on health, tourism, or fisheries.

Then, he introduced CliDEsc, a web-based CLEWS product generator. Also, he showed a few examples of CLEWS and CiDEsc such as report for Agriculture in Vanuatu, the Island Climate Update which shows long-term Pacific outlook based on ENSO models, and Southwest Pacific TC outlook.

2.4. PNG NWS – Mr. Kasis Inape (Assistant Director of Climate & Special Services)

Chair invited Mr. Kasis Inape from the PNG National Weather Services (NWS) to present the climate prediction services in Papua New Guinea.

Mr. Kasis Inape firstly introduced PNG NWS as a small meteorological service by international standards and much focus lies on aviation. The purpose of PNG NWS is to contribute to the economy's social, economic, environmental and cultural goals and these are achieved through 3 departments of PNG NWS.

The Climate & Special Services Department of PNG NWS where Mr. Kasis Inape is responsible for has roles of investigating the trends in the climate of PNG and producing climate summaries/review for clients. The department's functions are to conduct research in meteorology, to produce climate summaries and information, and to provide improved forecasting aids as a result of effective processing and analysis of climate data.

The climate prediction services in PNG are a fairly new concept and the seasonal climate predictions were issued since 2000. The climate prediction is based on simple statistical regression techniques. And the major tool for climate prediction in PNG is SCOPIC (Seasonal Climate Outlook for PIC's), which was developed to transform the operational seasonal climate prediction from the Australian Bureau of Meteorology into standalone PC program accessible to PIC's. The prediction system is statistical-based and generating probabilistic forecasts through correlation between predictors (Sea Surface Temperature Anomalies & Southern Oscillation Index) and predictands (rainfall and temperature). SCOPIC is used to develop capacity in PIC's NMHSs to provide seasonal climate outlooks for climate sensitive sectors and the general public. It has simple operation functions such as organizing data, exploring data, analyzing relationships, testing skills, generating reports, and drought analysis. Regarding the prediction skill, Mr. Inape explained that the SCOPIC skill drops in March to May and June to August with 1-month lead time from 1961 to 2014.

Mr. Inape also introduced SCOPIC Drought Watch, which is using SPI method. However, it is now under repairs due to some technical problems.

Mr. Inape then introduced the future plans in PNG climate prediction. The global trend is to use dynamical models and PNG is also using POAMA (Predictive Ocean Atmosphere Model for Australia), a dynamical ocean-atmosphere climate model for seasonal and intra-annual forecasts in Australia. BOM extended the model to Pacific region via PASAP (Pacific Adaptation Strategy Assistance Program) funded by the Department of Foreign Affairs and

Trade of Australia (DFAT) in 2011.

He then explained the efforts of PNG NWS on contextualizing climate science for food security in PNG with farming agency and on drought forecasting through CREWS-PNG (Weather & Climate Early Warning System for PNG) project.

Also, he stated that with support from Australia, PNG has developed the national strategic plan from 2019 to 2023. He also explained that there is a possibility for PNG NWS to move from the Ministry of Transport to the Department of Finance and Autonomy.

PNG has been appointed as one of GFCS (Global Framework for Climate Services) focus economies along with Bhutan, Burkina Faso, Dominica, Moldova, and Republic of Tanzania and is able to work together in an interdisciplinary manner to contribute to climate services. Under this program, Mr. Inape explained that there were 6 National Climate Outlook Forums (NCOFs). And 2 outlooks were released in the beginning of wet season and the end of dry season for better water resources management. And then he stated the next steps ahead such as institutionalizing the NCOF for PNG, setting up PNGCOF, and making joint submission among other government agencies to Cabinet for endorsement to implement GFCS with consistent basis.

Mr. Inape then made a conclusion statement that NWS has not been much focused on climate prediction since the main task was more operation basis. However with support from BOM and Australian government, PNG NWS is slowly progressing towards understanding the climate science better necessary to provide accurate and reliable climate prediction services for the economy.

And he finalized his presentation with a few recommendations that while there are much information available from different sectors from APCC, JMA, NIWA, and BOM, it is a challenge to coordinate the data to meet the needs. In order to be able to access the data, there needs to be capacity building activities for staff. Currently, PNG NWS recruited university students. And he highlighted the support through the Young Scientist Support Program from APCC and BOM to assist PNG NWS staff with appropriate climate science and prediction training programs.

2.5. CWB – Dr. Yeu-Woo Lin (Chief Secretary)

Chair appreciated the presentation from PNG NWS, and then invited Dr. Yeu-Woo Lin from the Central Weather Bureau of Chinese Taipei for the last presentation.

Dr. Yeu-Woo Lin started his presentation on climate services in CWB by stating there are two parts of climate. One is climate science with data collection, analysis, monitoring, and modeling and the other part is climate service, which is deeply connected with society. For climate service, it needs data reanalysis, cooperation among government agencies, user-oriented products, creating the value of climate information, interdisciplinary approach, and bilateral and multilateral international cooperation.

Dr. Lin, then, provided detailed explanation and examples of each component that is needed in climate services. Firstly, he introduced the climate data CWB received or produces. CWB has 26 climate observation stations throughout Chinese Taipei and 5 more stations now are under construction, and 532 automatic stations with 9 km apart between 2 stations. And CWB has automatic climate observation system (ACOS) which also has multi-module sensors and IP-based sensors.

In the context of climate change analysis, Dr. Lin explained that CWB worked on understanding the past climate change of the Chinese Taipei, and providing the information of climate change for government agencies to make national climate change adaptation policies.

CWB is also trying to understand the mechanism of large-scale phenomena acting on Chinese Taipei to develop forecast guidance through climate monitoring. It includes tropical cyclones, subtropical high, East Asian summer and winter monsoon, Boreal Summer Intra-seasonal Oscillation, ENSO, etc.

For climate modeling, CWB works on upgrading global coupled model with new ocean model and increasing the skill of sub-seasonal to seasonal (S2S) forecasts to provide user-oriented climate service. CWB started with 2-tier climate model from 2002 and changed to 1-tier coupled model from 2010 to 2015. From 2016 to 2019, CWB is using ensemble models, and in the future CWB plans to develop seamless forecast system.

In the climate prediction part, Dr. Lin explained that CWB is developing forecast guidance through model development, post-processing, and forecast guidance. He also introduced the evolution of CWB's climate prediction products from 1979 to now and mentioned that the products are released in different forms in different time scale. CWB is issuing monthly outlook, seasonal outlook, and annual report. Products are disseminated through various channels with a careful consideration on who the right person is to use data. And different forecast information is provided in a different time; spring rain outlook in February, plum rain outlook in April, TC outlook in June, autumn outlook in August, winter outlook in November, and global warming to the public in December.

Dr. Lin added CWB's efforts to develop the platform for cross-sectoral weather applications with interdisciplinary collaboration among government agencies in Chinese Taipei. Dr. Lin mentioned the cooperation across agriculture, fishery, transportation, health, and energy sectors with emphasis on local characteristics. He showed an example of collaborative work with the Council of Agriculture that CWB provides spring rainfall outlook for rice planting and 7-day township forecasts for agricultural products planting, and plans to provide extreme event probability information. He also shared that CWB tried to rewrite rice cultivation calendar because farmers have used the cultivation calendar based on their own experience and it caused problems due to environmental changes. There were many workshops conducted to listen from farmers and CWB applied the information to the new rice cultivation calendar. In fishery, the platform provides information to fishers, students, and parents, and has detailed search function and group management function in fishery section. CWB also

works with the Bureau of Water Resources and provides seamless forecast through customized system, the 2nd season outlook for water resources management, and seamless forecasts for drought prevention and adaption. Power companies in Chinese Taipei generate power based on coal, water, or gas. And CWB provides TC track forecasts for hydroelectric power management, and heat wave outlook for dry conditions. With the Bureau of Energy, CWB is working together for green energy development such as green energy forecasting system, assessment and optimization system, and monitoring system. For public health, CWB researched that the risk of dengue increases to the northern part of Chinese Taipei due to global warming.

Dr. Lin lastly introduced the international cooperation of CWB. He highlighted that the climate services requires learning experiences from the international community, and CWB has close cooperation with the National Oceanic and Atmospheric Administration (NOAA) for MJO forecast and APCC for BSISO forecast. CWB has bilateral relations with PAGASA through VOTE (Volcano, Ocean, Typhoon, Earthquake) project to improve the potential forecast and climate service; with Solomon Islands for establishing a multi-hazard early warning system for heavy rainfall, earthquake, and dengue fever; and with St. Kitts and Nevis for capability building project for climate change adaption in agriculture sector. Dr. Lin also shared that CWB and APCC co-hosted the 2019 International Workshop on Climate Prediction in June 2019 in Taipei. And then he introduced the upcoming Climate Service Workshop that CWB hosts on 28 – 29 June 2019 in Taipei and encouraged the APCC WG members to participate.

Dr. Lin concluded his presentation by stating that CWB is to provide science based climate service and information to responsible departments and civilian societies for safer and better lives.

3. Discussion

Chair thanked all the presenters for informative presentations regarding the organizations' climate prediction and services status. Then, he commented that while there are various products from NHMSs, it is also important and also a challenge to understand how to communicate with the users for using the products. He provided an example from DMC that, once a month, DMC calls different sectors such as agriculture or water resources management to explain the meaning of seasonal prediction information. However, he believes this effort is not enough and NHMSs need to know further how the users take this information into their tasks and actions. He opened the floor for discussion and asked for sharing experiences and ideas from members.

Ms. Rosalina De Guzman from PAGASA shared her experiences of disseminating information to the users. PAGASA conducted a workshop in a region and found out that the users did not receive the information (El Nino Watch) due to internet connection. She suggested that one possible way of reaching to the community is to work with civil society

and local community in order to make the information reach to the users. And she also asked other members for sharing other experiences or better ideas on reaching to the users.

Dr. Paul Gregory from BOM also highlighted the importance and priority of information in user groups.

Dr. Brett Mullan from NIWA stated that the difficulty in seasonal prediction is to connect with other sectors and agencies. He shared an experience with Energy sector where data was not shared with NIWA. He also shared a recent successful case with farmer community in subseasonal time scale information which involved social science community in addition to the farmers and NIWA.

Ms. Rosalina De Guzman pointed out that, in national level, seasonal prediction is important in the Philippines in various sectors especially in water and agriculture sectors. However, it is still a big challenge to reach to local community and make them understand the importance of seasonal prediction and make the use of the information.

Dr. Yeu-Woo Lin from CWB stated that the locals do not use cellphones in Chinese Taipei. There was a survey on the methods of how to receive information and the first device was TV and the second was radio. Therefore, CWB conducts exercises on shutting down all TV program and sending a short message of earthquake or thunderstorm in order to reach to the public in emergency cases.

Mr. Maytee Mahayosanunta from TMD also shared that TMD tries to use social media for reaching to the public. He then commented on the difficulty and importance of making users understand the climate service and that each group request different types of data. He also pointed out that the data and service need to be region-specific. For example, one part of Thailand experiences heavy rainfall while other part of the region faces with severe drought. This is not reflected in the averaged prediction information. Therefore, he emphasized on the importance of local impact and value and impact of climate information and services.

Mr. Muhammad Agung Fauzi from BMKG shared the qgency's experience of climate services to reach to climate information users by introducing BMKG's Climate Field School activities. The Climate Field School is an activity undertaken by BMKG aiming at increasing the accessibility and the use of climate services. The users mostly do not understand the forecast data or maps and therefore, in the school, experts translates the technical language to a plain language that farmers or the public could understand.

Mr. Gustavo De La Cruz Montalvo from SENAMHI agreed that the seasonal forecast is complicated to understand especially for the public and his organization tries many meeting swith stakeholders to teach how to interpret the information for them to use. Those meetings include a meeting with local communities to disseminate the information, and the organization utilizes social media for dissemination. Also SENAMHI makes a short video to explain the product in a more understandable language and context.

Chair of the APCC WG meeting also agreed on the importance of contacting and

communicating with final users. And then, he suggested creating a web-based forum to discuss further since APCC WG meeting is once a year. Then, the floor raised an issue of time difference among members for video or audio conference.

Dr. Won-Tae Kwon, Executive Director of APCC, suggested a form of online documentation program such as Google Docs. If there is an agenda to discuss among members, an online document can be open and the members would provide comments and share ideas. Dr. Kwon pointed out that this is a way to overcome the time difference while the ideas are collectively reflected, and this could be an example of sharing ideas and collaboration without the difficulty of physical meeting.

Ms. Sangwon Moon, a Head of the External Affairs Department of APCC, also expressed her impression on each member's willingness to share their experiences and lessons-learned stories. She stated that, in the past, the APCC WG meeting tended to be one-way transfer of information from APCC to the members, but the meeting becomes a venue for all members to share their activities and news with other members. She mentioned that members can always contact APCC if there is any information to share with other members such as the upcoming CWB workshop in October, and APCC is happy to be a facilitator to share them among members.

Finally, she added that APEC hosting economy for the next year is Malaysia and the plan for APCS 2020 and the next APCC WG meeting is under discussion. She stated that the plan will be shared among members once it is set.

4. Closing

Dr. Enrique Garrido Segovia, as the Chair of APCC WG meeting 2019, officially closed the meeting by appreciating all the members for participation.