出國報告（出國類別：國際會議）

出席 2018 年亞太氣候研討會報告
(APEC Climate Symposium, APCS)

服務機關：交通部中央氣象局
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派赴國家/地區：巴布亞紐幾內亞
出國期間：107 年 8 月 19 日至 8 月 24 日
報告日期：107 年 10 月 30 日

摘要

亞太經合會(Asia Pacific Economic Cooperation, APEC)氣候中心(APEC Climate Center, APCC)每年例行舉辦亞太氣候研討會(APEC Climate Symposium, APCS)。有來自全球 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齊聚一堂，共同討論氣候預測及服務在氣候資訊應用方面的新興議題。2018 年 APCS 在 8 月 21 日至 23 日，於巴布亞紐幾內亞 (Papua New Guinea，以下簡稱巴國)首都-摩士比港(Port Moresby)舉辦，主辦單位有 APCC、巴國的環境保護與氣候變遷部及國家氣象局，我國的中央氣象局更是首次以協辦單位角色出席會議，實屬難得。

APCS 之目的，在於提供一個跨領域的溝通與互動場所，期能促進亞太地區有關最新的氣候預測技術與知識之交流。2018 年的主題為「藉由強化氣候資訊和服務，應對不確定未來的挑戰」，3 大次要主題分別是①加強氣候資訊的應用，②通過氣候資訊與服務改善水和糧食安全，③連結氣候資訊與政策制定。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，以利農業和水資源領域能對氣候資訊有更多的了解及應用。

關鍵詞：氣候變遷、氣候預報、氣候資訊應用、糧食安全、水資源

目次

一、目的

亞太經合會(Asia Pacific Economic Cooperation, APEC)之會員包含太平洋的臺灣、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)的天氣及短期氣候預報資料，經整合及分析，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。

APEC 自 2004 年起，每年均舉辦亞太氣候研討會(APEC Climate Symposium, APCS)，此研討會為 APCC 年度盛事。最特別的是，本次 2018 年 APCS 由巴國主辦，除該國環境保護及氣候變遷部及國家氣象局外，我國中央氣象局亦為協同主辦單位之一，為中央氣象局協辦 APCS 此類國際研討會的首例。本次研討會在 8 月 21 日至 23 日，於巴國首都，即摩士比港舉辦，主題為「藉由強化氣候資訊和服務，應對不確定未來的挑戰」，來自世界各地大約一百名與會人員，成員包含各經濟體的科學家、各國的氣象水文部門代表、國際專家、學術界代表、政策制定者、民間公司及媒體等其他機構等相關人士。

在本次研討會，由中央氣象局葉天降局長、李明營技士與李清縢副研究員與會，從臺灣一同前往的還有美國猶他州立大學的王世宇教授，及中華經濟研究院的林桓億博士，一行共 5 人。葉局長於開幕式受邀上臺致詞，王世宇教授及林桓億博士亦先後擔任演講者，王世宇教授更是主題一、四的主持人，對本次研討會能順利完成貢獻良多。在本次研討會中，臺灣、中央氣象局一再被提及，對於增加我國的國際能見度有莫大的助益。

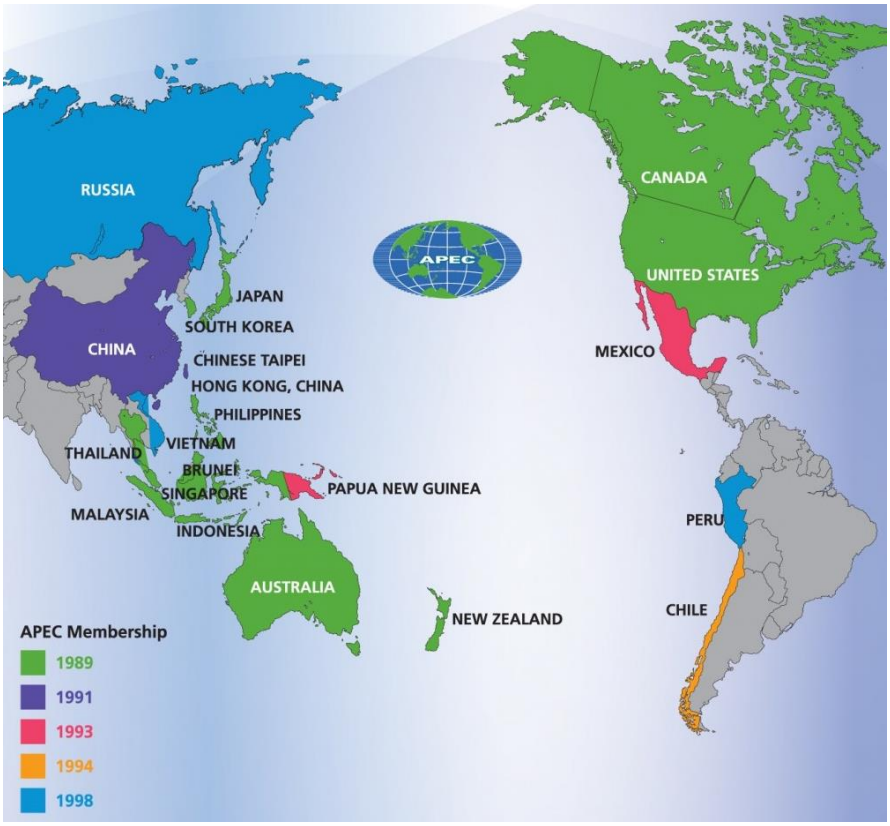


圖 1. APEC 會員及入會年份，圖檔來源：http://www.transpacificproject.com/

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組織，本國中央氣象局(第 2 排右 2)亦是其中一員，圖檔來源為 APCC。

二、過程

此次與會行程說明如下：

日期	地點與相關工作內容
2018/8/19~8/20	出發前往，臺北→菲律賓馬尼拉→巴國亞摩士比港。
2018/8/21~8/23	參加 2018 年亞太氣候研討會(APEC Climate Symposium, APCS) 1. 8 月 21 日, 8:00~12:30：註冊、開幕、關鍵議題講座。 2. 8 月 21 日, 13:30~18:00：主題一，加強氣候資訊的應用。 3. 8 月 21 日, 18:00~20:00：迎賓晚宴。 4. 8 月 22 日, 9:00~13:15：主題二，通過氣候資訊與服務改善水和糧食安全。 5. 8 月 22 日, 14:00~18:00：主題三，連結氣候資訊與政策制定。 6. 8 月 22 日, 18:30~20:30：晚宴。 7. 8 月 23 日, 9:00~12:20：綜合討論及閉幕典禮。
2018/8/24	返國，巴國亞摩士比港→菲律賓馬尼拉→臺北。

此次研討會的簡報及相關資料，APCC 整理在以下網址：

https://www.apcc21.org/ic/apsView.do?lang=en&bbsId=BBSMSTR_000000000031&nttId=5860&pageIndex=1&recordCountPerPage=10&searchCnd=&cate1=&searchWrd

本次研討會的議程如附錄 1。在 2018APCS 開幕式上，首先由 APCC 董事會主席 Dongin Lee 教授致開幕辭。接著由兩位巴國的當地官員，環境保護與氣候變遷部長 Hon. John Thomas Pundari、總理辦公室和全國執行委員會的 Amb. Ivan Pomaleu 發表歡迎辭。

最後，由本國中央氣象局葉天降局長獻上祝賀辭。緊接著，APCC 的代理執行主任 Jin Ho Yoo 博士贈送巴國及我國中央氣象局等各個協辦單位感謝牌。最後，所有與會人員移步至會議大樓之前，一起留下和樂融融的大合照(圖 3)。

圖 3. APCS2018 開幕式的照片，左上、右上、下圖，依序是葉天降局長致詞、APCC 贈送中央氣象局感謝牌、所有參與者的大合照。照片來源為 APCC，下載連結為 https://www.flickr.com/photos/apcc21/albums/ 72157700426205494

在開幕式之後，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. 加強氣候資訊的應用(Linking Climate Information and Decision-Making)。
2. 通過氣候資訊與服務改善水及糧食安全(Improving Water and Food Security with Climate Information and Services)。
3. 連結氣候資訊與政策制定(Linking Climate Information and Decision-Making)。

議程最後一天第 3 日的上午邀請臺灣赴美的王世宇教授、Jong Ahn Chun 博士、Chalapan Kaluwin 教授 3 人，分別針對上述 3 大主題，帶領與會人員回顧及討論相關議

題。最後，由 Alberto Troccoli 教授主持綜合討論(Session IV: Wrap-up & Panel Discussion)。各演講者的報告內容，擇要摘述如下：

(一)關鍵議題講座

關鍵議題的 2 位演講者均來自澳洲，分別是澳洲國立大學的 Mark Howden 教授，及負責氣候變遷且服務於聯合國開發計畫署(United nations development programme)的 Edward Vrkic。2 位講者都提到，氣候變遷已是現在進行式，我們不可忽視，應要積極面對。然而，Mark Howden 教授認為，因為氣候變遷的科學家談的是幾十年後的久遠推估，或是北極海冰等地球彼端的遙遠現象，這些時空的距離疏遠了民眾對氣候變遷的關心。另外，科學家著眼的溫室氣體對民眾而言是看不見、摸不著，百年上升幾度、溫室氣體濃度增加多少等，這些冷冰冰的科學數據對大眾而言是無感的。這個存在於對專業知識的認知差異，讓民眾認為氣候變遷是個抽象且不易了解的議題。Mark Howden 教授也提到，不僅民眾對於氣候變遷有認知不足的問題，氣候相關資訊提供者也不太了解使用者需要何種資訊，即使是降尺度技術的氣候資訊，符合使用者需求的比率也只有 23%。舉例來說，有 77%的產業人員認為科學家說的幾十年後之情境推估太過遠久，他們要的只是近期 5 到 20 年的氣候資訊。因此，Mark Howden 教授呼籲，科學家與民眾、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。

(二)主題一：加強氣候資訊的應用

來自韓國 APCC 的 WonMoo Kim 介紹 APCC 現有的氣候服務，產品、能力等，包含他們發展的太平洋島國進階季節展望(Pacific Island Countries Advanced Seasonal Outlook, PICASO)，PICASO 是專為太平洋島國設計的季節預報系統，結合了動力及統計季節預報。WonMoo Kim 指出，多重動力模式的系集平均是目前預報能力最優秀的方法，單一動力模式其次，統計模式則較為不佳。然而，PICASO 更在目前表現最優的多重動力模式系集平均之上，這主要是因為 PICASO 將系集動力模式進行一個修正的後處理，進而提高原有動力系集模式的預報能力。WonMoo Kim 亦以圖 4 呼應在關鍵議題中被提出的觀念，這個似指南針有 4 個方向的圖示，說明了氣象資訊服務應有

的 4 個面向，分別是 N(Need-drive，需求導向)、E(Excellency，追求高品質)、W(Work together，溝通協調)、S(Sustainability，永續發展)。也就是氣象資料提供者要以使用者角度出發(需求導向)；使用降尺度、統計後處理等技術將氣象資訊的品質提升(追求高品質)；氣象資訊提供者、使用者雙方要相互溝通協調，了解兩方的能力與需求(溝通協調)；最後，氣象資訊提供系統(單位)要能永續經營，持續進步(永續發展)。

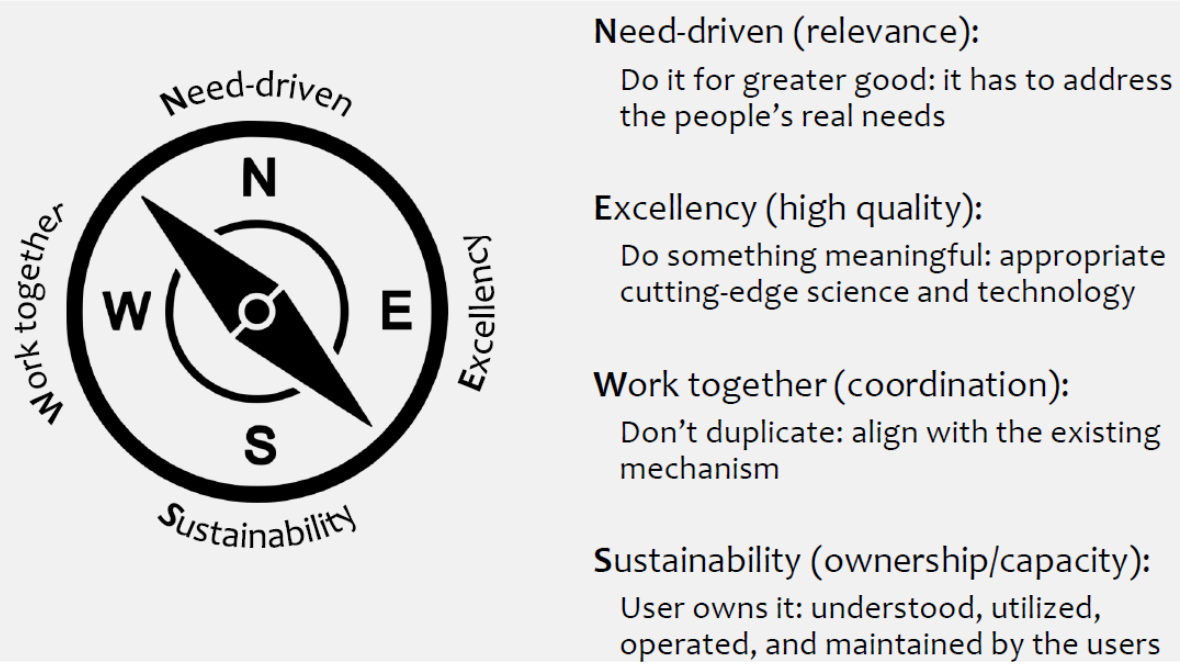


圖 4. 氣象資訊服務應有的 4 個面向，圖摘自 WonMoo Kim 的簡報。

王世宇教授是來自臺灣的學者，他畢業於中央大學，隨後至愛荷華州立大學完成博士學位，目前任教於美國猶他州立大學。他認為相較於一般氣象學，氣候預報更是個更加艱難的任務。王教授專精於氣候極端事件的研究，對於今(2018)年夏季發生於日韓的熱浪提出了初步分析看法，認為在全球暖化效應下，乾濕季的變化振幅會被放大(即乾季更少雨，濕季雨量更多)，並推論此次熱浪事件就是一個與暖化有關的極端氣候事件。此外，王教授亦提到曾與中央氣象局合作，共同探討 2016 年年初被臺灣媒體稱為霸王級寒流的個案，他推測該次寒流事件與北極的暖化有關，又是一個受暖化影響的極端氣候事件，該研究已發表於國際知名期刊(Geophysical Research Letters, 10.1002/2017GL073012)。

Philip Malsale 服務於太平洋區域環境規劃組織(Secretariat of the Pacific Regional Environment Programme)，他介紹「太平洋島國的季節氣候展望系統(Seasonal Climate Outlook for Pacific Islands countries, SCOPIC)」。SCOPIC 是由澳大利亞為了太平洋區域發展的季節預報系統，最大的特點是可安裝於一般的個人電腦，資訊需求低。SCOPIC 需要預報地點的歷史測站觀測資料，使用海溫及南方振盪指數(Southern Oscillation Index, SOI)，應用統計方式做出 3 個月的預報(個人判斷，最大的預報訊號應該來自聖嬰現象及印度洋偶極現象)。Philip Malsale 也介紹了「太平洋氣候資訊平台(CLimate Information toolKit for the Pacific, CLIKⓟ)」，CLIKⓟ為韓國 APCC 發展的線上降尺度預報系統，可提供太平洋島國更細緻的季節預報資訊，該系統的網址為 http://clikp.sprep.org。

Rebecca A. Boliner 女士是來自美國的研究員，與同樣來自美國的 David Letson 教授都談論到氣象提供者與使用者需要能相互溝通。David Letson 教授更介紹他們在 2005 年起建立的農業氣候網站(http://mz.agroclimate.org/)，該網站提供了許多農業與氣候的相關資訊，有助於農業在處理與氣候的相關風險中，能提早因應並有較佳的管理策略。

Alberto Troccoli 教授目前任職於世界能源與氣象委員會(World Energy & Meteoro- logy Council)，他指出近幾年再生能量的發電量不斷地提升。然而，在 RCP[1]8.5 的情境模式之下，2050 年代前後(2040-2069 年)全球平均河流流量會下降，這將導致約 61-74 %(相較於 1971-2000 年)水力發電站的發電量降低。Alberto Troccoli 教授簡介了數個氣候網站，分別是氣候資料庫(Climate DataStore, https://cds.climate.copernicus.eu/)，內容包含觀測，全球和區域氣候再分析、氣候預報等。另一網頁是提供氣候變遷相關資訊的哥白尼氣候變遷服務(Copernicus Climate Change Service, https://climate.copernicus. eu/)。Alberto Troccoli 教授亦分享由他纂寫的電子書的下載網址，能源工業的天氣和氣候服務(Weather & Climate Services for the Energy Industry, https://link.springer.com/book/10.1007% 2F978-3-319- 68418-5)，內容包含 13 個章節，總頁數 212 頁。Alberto Troccoli 教授認為，氣候服務能夠成為能源

[1] RCP 代表濃度途徑(Representative Concentration Pathways, RCP)是 IPCC 第 5 次評估報告中，用來定義未來變遷的情境，以輻射強迫作用在 2100 年與 1750 年之間的差異量當作指標性的數值來區分。其中 RCP2.6 代表輻射強迫作用在 2100 年增加了 2.6(Watt/m2)，同理 RCP4.5、RCP6.0 與 RCP8.5 分別增加了 4.5、6.0 與 8.5(Watt/m2)，數值愈大代表溫室氣體控制措施愈不積極，暖化情境愈嚴峻。

規劃、營運與維護的有用工具，若氣象、能源兩方面的人員能有更多的溝通、交流，對於綠能開發將有顯著的助益。

(三)主題二：通過氣候資訊與服務改善水和糧食安全

Toshichika Iizumi 博士來自日本，他提到由於人口成長，全球糧食需求總量將在 2050 年達到現今的兩倍；而且，在暖化的未來，4 個糧食產量大國，包含中國、美國、阿根庭、巴西的糧食產量除總量減少外，變異量亦會加大，這將會使得全球糧食價格升高、變動放大。Toshichika Iizumi 博士說到氣候事件，如聖嬰、印度洋偶極等現象均能左右全球糧食產量，農糧單位亦十分關心當今的氣候現況。因此，在農業市場資訊系統(The Agricultural Market Information System, http://www.amis-outlook.org/)網頁中就有許多氣候的相關資訊。Toshichika Iizumi 亦提到若能妥善應用季節預報，就能在 1 至 6 個月之前推估糧食產量，足見季節預報對農業的重要性，若有更精確的季節預報，就能提高農業面對氣候變遷的適應力。此外，根據 Toshichika Iizumi 的研究，推估 21 世紀末 4 個主要糧食作物在何種暖化情境下就會發生產量停滯，其中玉米在多數區域(含臺灣，見圖 5 左上)即使是 RPC2.6 情境(即溫室氣體控制的最佳，暖化程度最低)也會發生產量停滯；相對來說，稻米對暖化的調適能力較佳，東亞區域要到 RCP6.0 或 RCP8.5 才會出現產量停滯(圖 5 左下)。

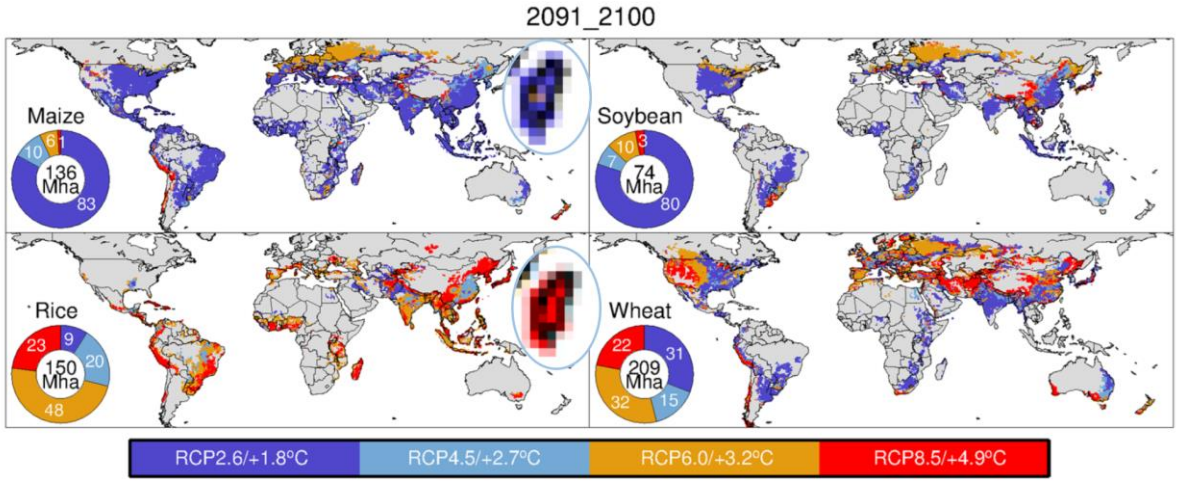


圖 5.推估糧食(玉米、大豆、稻米、小麥)在何種暖化情境下會發生產量停滯。顏色代表 4 個不同的 RCP 情境。其中，左方圖兩張橢圓小圖為本報告將臺灣附近放大並貼上的，因大豆、小麥在臺灣無資料，所以沒另外再放大貼上。摘自 Toshichika Iizumi 簡報，該研究發表於 Iizumi et al. (2017), Sci Rep, doi:10.1038/s41598-017-08214-4

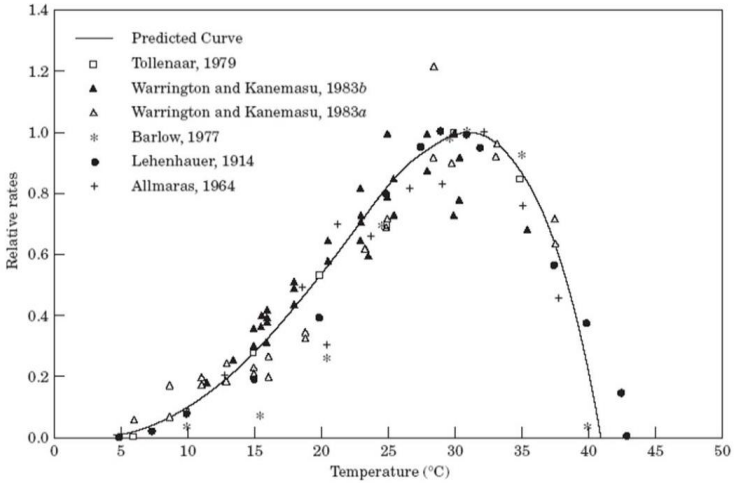


圖 6. 玉米的成長速率(縱軸)與溫度(橫軸)的相關性，不同點代表不同的研究，直線代表推估的擬合曲線，圖摘自 Denis Timlin 簡報。

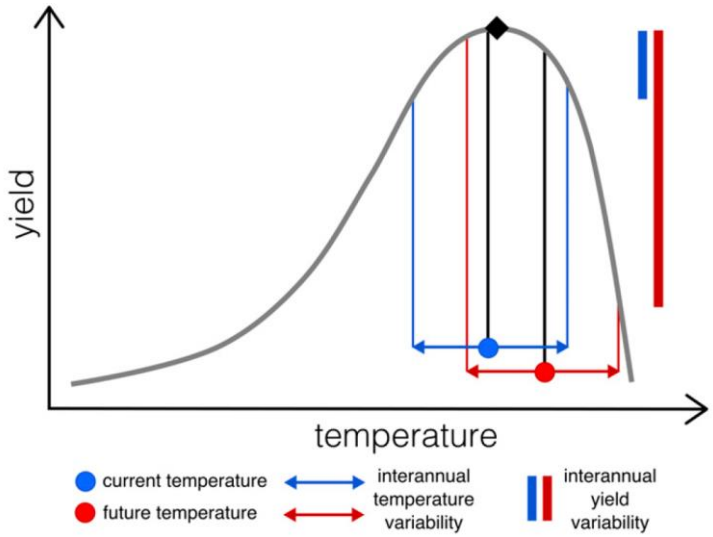


Fig. 1. Schematic representation of temperature-yield relationship. In the absence of breeding for heat tolerance, an increase in mean temperature beyond the optimum temperature (♦) will lead to a decrease in mean yield and an increase in yield variability, assuming interannual temperature variability stays the same.

圖 7. 說明為何氣溫增暖為何會使糧食產量的變異量變大的示意圖。橫軸為溫度，縱軸為產量，黑色曲線為溫度與產量的擬合曲線，圖中◆代表最佳理想生長溫度(optimum temperature)。藍、紅色雙箭頭代表現今、未來的溫度變化範圍；藍、紅垂直粗線代表現今、未來糧食產量的變化。由此示圖可知，因溫度增暖使得環境偏離植物的最佳生長溫度，糧食產量變化幅度加大許多。圖摘自 Tigchelaar et al., 2018: Future warming increases probability of globally synchronized maize production shocks. www.pnas.org/cgi/doi/10.1073/pnas.1718031115

美國的 Denis Timlin 教授也是農業專家，他說明因為溫度升高會使得農作物的生長加速，生長需求時間因此會縮短，進而導致植株較小、接收到的太陽光變少，最後使得農作物產量潛力也跟著變少。然而，植物的生長速率與溫度不是簡易的線性相關，以玉

米為例，兩者相關性如圖 6，玉米最佳理想的生長溫度大約是攝氏 31 度。在 Denis Timlin 教授的演講中，我回想起先前研讀的期刊，內容描述暖化是如何造成糧食產量變異度變大的示意圖(圖 7)。Denis Timlin 教授亦提到，目前的作物模型(crop model)多數是在 20 到 30 年前開發的，並沒有跟著我們對作物生理學、作物與環境的相互作用的了解能力提升而調整，因為作物模式是應對氣候變遷最佳的利器，發展新的作物模式勢在必行。關於二氧化碳濃度的影響，Denis Timlin 教授討論到二氧化碳濃度升高，會導致植物氣孔導度降低，植物的水分利用效率進而提升；但二氧化碳濃度對植物的其他影響了解所知甚少。而且，不同的植物對二氧化碳濃度變化的反應可能不同。因此 Denis Timlin 教授在溫室中進行一些實驗，試圖將植物對於氣象、土壤等因素的反應有更深入之了解。

Ramakrishna Akkinapally 是巴國當地的官員，他提到因海平面上升，吉里巴斯發現有部分土地已受到鹽水侵入。土耳其的 Nuket SIVRI 博士介紹她的國家一些美麗的湖光山色，接著提到因降水減少，許多湖面面積愈來愈小。Rijan Bhakta Kayastha 來自於世界的屋脊-尼伯爾，他根據 1977 年至 2010 年期間的觀測資料表示，尼伯爾的冰川面積已減少了 24%(38 平方公里/年)。APCC 的 Joon Ha Kim 主任是主題二最後一位演講者，其演講內容比較特別，講述目前已進入第四次工業革命，特點是各種學門的跨域合作，這將模糊物理，數學和生物領域之間的界限。在第四次工業革命中，觸控技術、3D 列印、虛擬實境、生化科技、無人航器、人工智慧、大數據等是此次革命的關鍵技術。Joon Ha Kim 相信，我們目前面臨氣候變遷帶來的衝擊，有機會透過這些新技術來緩和，並呼籲建立完整的氣候大數據是很重要的。

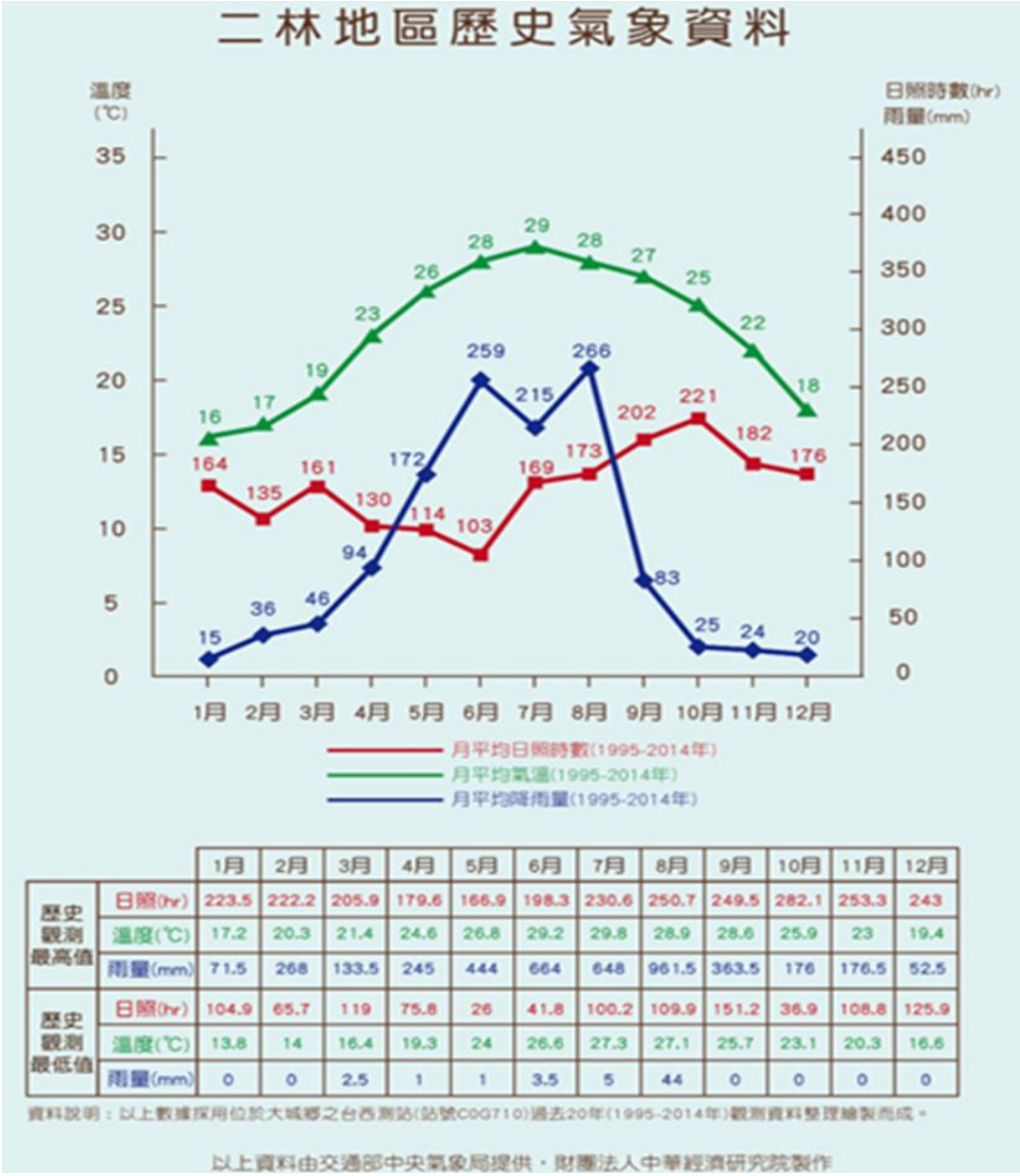
(四)主題三：連結氣候資訊與政策制定

Elisabeth Simelton 女士是世界農林業中心(World Agroforestry Centre)的科學家，她介紹了「氣候變遷、農業與食安」的計畫，此計畫為農民提供氣候相關資訊與和諮詢服務，網頁為 https://ccafs.cgiar.org/flagships/climate-information-and-advisory-services- farmers。她亦分析了東南亞婦女和少數民族對農業氣候資訊的看法，並歸納出氣象服務有以下幾個缺點，包含氣象資訊的尺度太大，資訊過於專業學術，不易被理解，實用性亦不太高等。

韓國大學的 Hojeong Park 教授談論到一些「不確定性」的計算公式，並認為減緩氣候變遷衝擊的投資效益不是立即見效的，需要過一段時間之後，效益才會愈來大；而且，愈早開始，收益愈大，愈能減少氣候變遷的衝擊。巴國的 Chalapan Kaluwin 教授在簡報中談論一些氣候變遷的相關常識，以及該國的現況。

美國猶他州立大學教授 Jagath J. Kaluarachchi 比較兩個不同氣候型態的區域，探索兩地之氣候變遷的潛在威脅。其一為位於埃及西部的沙漠綠洲區，屬於乾旱氣候區，水源來自不可再生的砂岩含水層，當地由於地下水超限利用，導致 1960 年以來有 6 個鹼水湖形成。更由於地下水的鹽度逐年遞增，導致農作物收益逐年遞減。Jagath J. Kaluarachchi 利用氣候模擬推估，在 RCP4.5 情境中地下水尚能永續維持，但處於 RCP8.5 情境時地下水將會短缺。另外，在亞洲季風區的孟加拉恆河三角洲方面，除面臨極端的高低溫頻率增加外，連續性降雨及乾旱時期亦延長，短時強降雨亦有強度加劇的現象。

研討會最後一位演講者，由來自臺灣中華經濟研究院的林桓億博士壓軸演出。他由簡介中華經濟研究院、臺灣及中央氣象局開場，接著談論到他與中央氣象局合作的計畫。該計畫在 2013 年對 400 戶農戶進行了成功的實地訪查，統計分析出臺灣大部分的農民都是從電視中的氣象報導來取得、了解氣象預報資訊，並建議中央氣象局如果想要與農民進行交流互動，或是想提供農民在氣象上更多幫助，應考慮以電視為主要媒介，同時應該考慮電視頻道應以無線數位頻道為主，並加強使用語言的多樣性，例如臺語或客語。林博士也提到，中央氣象局有接受他們的建議，在對於農民如何使用氣象資訊上有更多的了解。在氣象資訊推廣與服務方面，林博士以彰化縣二林鎮為例，他的團隊與中央氣象局合作，對農民舉辦許多場次的教育訓練與座談會，更在農民常習慣翻閱的農民曆置入氣候相關資訊(圖 8)，為客製化氣象推廣服務的成功案例之一。



		1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
歷史觀測最高值	日照(hr)	223.5	222.2	205.9	179.6	166.9	198.3	230.6	250.7	249.5	282.1	253.3	243
	溫度(℃)	17.2	20.3	21.4	24.6	26.8	29.2	29.8	28.9	28.6	25.9	23	19.4
	雨量(mm)	71.5	268	133.5	245	444	664	648	961.5	363.5	176	176.5	52.5
歷史觀測最低值	日照(hr)	104.9	65.7	119	75.8	26	41.8	100.2	109.9	151.2	36.9	108.8	125.9
	溫度(℃)	13.8	14	16.4	19.3	24	26.6	27.3	27.1	25.7	23.1	20.3	16.6
	雨量(mm)	0	0	2.5	1	1	3.5	5	44	0	0	0	0

圖 8. 在彰化縣二林鎮的農民曆中，加入氣候相關資訊，為氣象推廣服務的成功案例之一。(摘自林桓億博士的簡報)

(五)工作小組會議

APCC 每年於 APCS 研討會同時舉辦 APCC 工作小組會議(APCC Working Group Meeting)，APCC 工作小組由 APEC 主任與各會員推派一人組成，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 22 日 14 至 16 時與氣候研討會並行舉行。參加人員包含：

- 巴國氣象局長 Mr. Samuel Maiha (Director, National Weather Service, Papua New Guinea)，

並擔任工作小組會議主席(輪值國代表為會議主席，APCC 主任為會議副主席)。

- 澳洲氣象局代表 Mr. Kasis Inape (Research Assistant, Bureau of Meteorology, Australia)。
- 智利氣象局副局長 Dr. Enrique Garrido Segovia (Deputy Director, Dirección Meteorológica de Chile, Chile)。
- 中央氣象局局長 Dr. Tien-Chiang Yeh (Director-General, Central Weather Bureau, Chinese Taipei)。
- 印尼氣象局應用氣候與資訊服務組副組長 Mr. Joko Budi Utomo (Deputy Director of Applied Climate Information Service, Indonesian Meteorological Climatological and Geophysical Agencies, Indonesia)。
- 日本氣象廳代表 Mr. Yoshiaki Sato (Senior Coordinator for Climate Modeling, Japan Meteorological Agency, Japan)。
- 韓國氣象廳氣候政策組副組長 Mr. Kuh Hee Cho (Deputy Director of Climate Policy Division, Korea Meteorological Administration, Republic of Korea)。
- 馬來西亞氣象局代表 Dr. Ahmad Fairudz Jamaluddin (Meteorological Officer, Malaysian Meteorological Department, Malaysia)。
- 菲律賓氣象局氣象服務組組長 Ms. Edna Juanillo (Weather Services Chief, Philippine Atmospheric, Geophysical and Astronomical Services Administration, the Philippines)。
- 泰國氣象局副局長 Dr. Songkran Agsorn (Deputy Director-General, Thailand Meteorological Department, Thailand)。
- 越南氣象與水文局副局長 Mr. Le Thanh Hai (Deputy Director General, Viet Nam Meteorology and Hydrology Administration, Viet Nam)。
- APCC 代理主任(Co-Chair) Dr. Jin Ho Yoo (Acting Executive Director, APCC)為會議副主席。

- APCC 國際組組長 Ms. Sangwon Moon (Head of External Affairs Department, APCC)。
- APCC 工作人員 Ms. Suhee Han (Project Manager, External Affairs Department, APCC)，Rapporteur。

與會人員合照見圖 9。小組會議包含 APCC 近況與工作報告、各會員國介紹與建議與綜合討論，中央氣象局葉天降局長於工作小組報告強化中央氣象局與 APCC 合作作為(Enhancing Collaborations between CWB and APCC)，介紹中央氣象局提供 APCC 資料與參與 APCC 活動情形，並提供後續強化 APCC 服務之建議，詳細之報告內容如附錄 2，完整之 APCC 工作小組會議記錄如附錄 3。

圖 9. 2018 APCC 工作小組出席人員合影。前右 1 智利氣象局副局長、右 3 會議主席巴國氣象局長、左 3 泰國氣象局副局長，後左 1 APCC 國際組組長、左 2 中央氣象局葉天降局長、左 3 APCC 代理主任。

在研討會之後，在大家的相互邀約下，李明營技士與王世宇教授、李清縢副研究員、林桓億博士、David Letson 教授、中國國家氣候中心的王遵婭女士等人共同聚餐、閒聊(圖 10)。由於中國國象氣候中心與李明營所任的中央氣象局長期預報課有相似的業務職掌，特別詢問王遵婭(圖 10 著綠衣)女士的工作內容，從而了解到兩個單位都是負責短期氣候預報、監測，且雙方的作業方式、業務、工作重點皆相當類似，惟中國國家氣候

中心的人力與資源是中央氣象局長期課人力的數倍。

圖 10.研討會結束之後，與友人聚餐、交流的留影。李明營技士為右 1 著直條襯杉者，左 1 為大陸王女士。

三、心得與建議

本次能獲邀出席 2018 年 APCS，在研討會聆聽來自各領域的專家學者，講述氣候變遷與糧食安全、水資源的相關議題，著實吸收到不少新知職，收穫豐碩。

在此次研討會中，許多專家認為未來糧食需求會因人口上升而增加，而且糧食產量可能因氣候變遷而下降，這將導致糧食價格上升、價格波動加大，對糧量供應有更大的挑戰。此外，研討會的專家學者均同意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。

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。在中央氣象局官網也有幾個口語化的預報產品，如天氣小幫手、天氣週報等單元。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。

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℃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。因此，今年能協助與 APCC、巴國合辦 2018APCS 就是個良好的開始，冀望未

來還是維持這種國際合作的模式，除能從研討會中吸受到新知外，還能與國際交流，增加臺灣及中央氣象局的國際能見度，是件一舉數得的美事。

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，韓國的 APCC 已成為可獨當一面，領導區域氣候發展的重要單位。再另外，中國大陸在與其國家氣候中心的王遵婭女士交流中了解到，中國大陸與臺灣在短期氣候上的業務、職掌十分相似，但前者投入的人力與經費是後者的數倍，這將可能導致兩方在短期氣候上的能力差異會愈差愈遠。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 3 點建議如下：

1. 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。

2. 持續維持國際合作，多以主辦或協辦角色參與國際會議及課程。

   此次中央氣象局協助 APCC、巴國合辦 2018APCS，讓臺灣及中央氣象局在此國際場合上為與會者關注，是個相當成功的例子。期盼此類國際合作模式還能持續下去，除能從研討會中吸收到新知外，為地球的未來盡一分責任與心力的我們，也許還能得到「德不孤，必有鄰」的效益，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。

3. 長期投資氣候能力建設。

   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。然而，

在氣候變遷衝擊漸勢嚴重的現在與未來，投資氣候能夠提升短期氣候預報能力，並達到預警、減災之良好益處。

附錄 1，研討會議程

Tuesday August 21, 2018

08:00-09:00	**Registration**	
09:00-10:00	**OPENING CEREMONY**	**MC: MS. SANGWON MOON** Head of External Affairs Department, APEC Climate Center
09:00-09:10	Opening Remarks	**PROF. DONGIN LEE** Chairman of Board of Trustees, APEC Climate Center
09:10-09:20	Welcome Remarks	**HON. JOHN THOMAS PUNDARI** Minister, Ministry of Environment & Conservation and Climate Change of PNG
09:20-09:30	Congratulatory Address	**AMB. IVAN POMALEU** SOM Chair 2018, Office of Prime Minister and National Executive Council of PNG
09:30-09:40	Congratulatory Address	**DR. TIEN-CHIANG YEH** Director-General, Central Weather Bureau of Chinese Taipei
09:40-10:00	**Commemorative Plaque Presentation and Photo Session**	
10:00-10:30	**Coffee Break**	
10:30-12:30	**KEYNOTE SESSION** Climate Change and Our Challenges	**Chaired by DR. JIN HO YOO** APEC Climate Center
10:30-11:10	Climate Change: Connecting Knowledge and Action	**PROF. MARK HOWDEN** Director, Climate Change Institute, Australian National University
11:10-11:50	Is It Time to Think about Climate Change as Weathernomics?	**MR. EDWARD VRKIC** Senior Advisor – Climate Change, United Nations Development Programme
11:50-12:30	Wrap-up and Discussion	
12:30-13:30	**Luncheon**	
13:30-18:00	**SESSION I** Enhancing Climate Information Applications	**Chaired by PROF. SIMON S. Y. WANG** Utah State University
13:30-14:00	Gaps and Opportunities in Climate Information Services	**DR. WONMOO KIM** Research Fellow, APEC Climate Center
14:00-14:30	Capturing Where People Aren't Looking - in Enhancing Climate Prediction Information	**PROF. SIMON S. Y. WANG** Associate Professor, Utah State University
14:30-15:00	Dynamical, Statistical and Traditional Climate Forecasting in the Pacific Island Countries: What We Do Now and Challenges for Future	**MR. PHILIP MALSALE** Climatology Officer, Secretariat of the Pacific Regional Environment Programme
15:00-15:30	**Coffee Break**	
15:30-16:00	Developing a Regional Drought Outlook Product Using Seasonal Forecast Information	**DR. REBECCA A. BOLINGER** Research Associate III, Colorado Climate Center, Colorado State University
16:00-16:30	AgroClimate for Climate –Smart Agriculture	**PROF. DAVID LETSON** Professor, University of Miami
16:30-17:00	What Can European Climate Services Offer to the Energy and Water Resource Sector?	**PROF. ALBERTO TROCCOLI** Co-founder and Managing Director, World Energy & Meteorology Council
17:00-18:00	Wrap-up and Discussion	
18:00-20:00	**Welcome Reception**	

附錄 1，研討會議程(續)

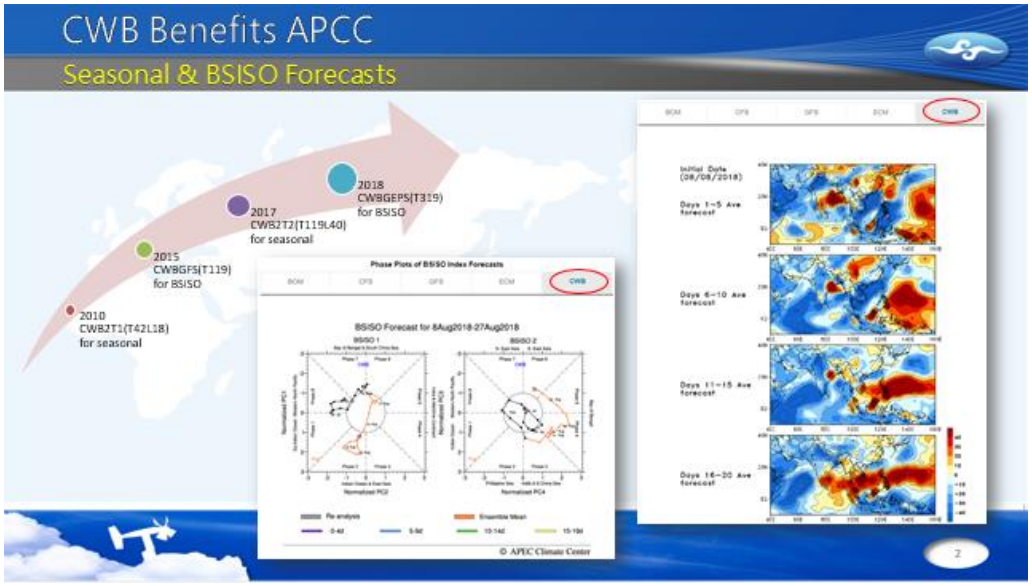
Wednesday August 22, 2018

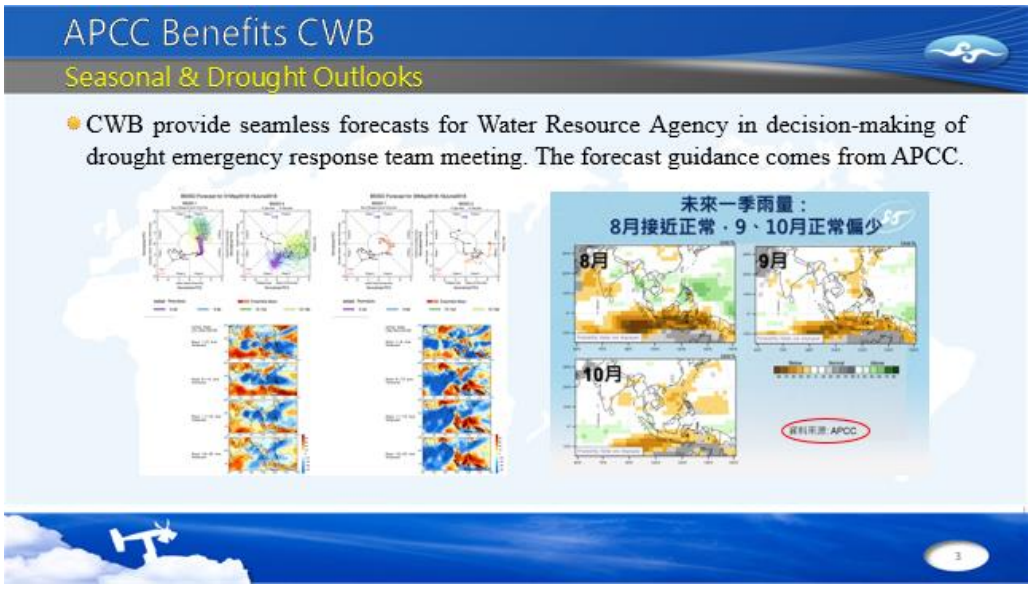
09:00-13:15	**SESSION II** Improving Water and Food Security with Climate Information and Services	Chaired by DR. JONG AHN CHUN APEC Climate Center
09:00-09:30	Global Crop Yield Forecasting using Seasonal Climate Information from a Multimodel Ensemble	**DR. TOSHICHIKA IIZUMI** Senior Researcher, National Agriculture and Food Research Organization, Japan
09:30-10:00	Incorporating CO2 Responses into Crop Simulation Models	**DR. DENNIS TIMLIN** Research Soil Scientist, United States Department of Agriculture
10:00-10:30	Adaptation Options for Climate Sensitive Development	**DR. RAMAKRISHNA AKKINAPALLY** Deputy Director-General, National Agriculture Research Institute, PNG
10:30-10:45	Coffee Break	
10:45-11:15	Impacts of Climate Change on Turkey's Special Water Resources	**PROF. NUKET SIVRI** Professor, Istanbul University
11:15-11:45	Use of Climate Information in Nepal for Water and Food Security	**PROF. RIJAN BHAKTA KAYASTHA** Associate Professor, Kathmandu University
11:45-12:15	Water, Climate Change, and 4th Industrial Revolution	**PROF. JOON HA KIM** Director, International Environmental Research Institute, Gwangju Institute of Science and Technology
12:15-13:15	Wrap-up and Discussion	
13:15-14:00	Luncheon	
14:00-18:00	**SESSION III** Linking Climate Information and Decision-Making	**Chaired by PROF. CHALAPAN KALUWIN** University of Papua New Guinea
14:00-14:30	Closing Actionability Gaps of Climate Services for Farmers, Agriculture Planners and Advisors – Southeast Asian examples	**DR. ELISABETH SIMELTON** Climate Change Scientist & CCAFS Project Manager, World Agroforestry Center
14:30-15:00	Robust Decision Making Process under Scientific Uncertainty on Climate Change	**PROF. HOJEONG PARK** Professor, Korea University
15:00-15:30	Linking Climate to Water Security: Case Studies from the Western Desert of Egypt and the Ganges Delta Region of Bangladesh	**PROF. JAGATH J. KALUARACHCHI** Professor, Utah State University
15:30-16:00	Coffee Break	
16:00-16:30	Climate Change, Variability and Sea Level Changes Poses Long Term Disasters in Achieving Responsible Sustainable Development in the APEC and Pacific Island States	**PROF. CHALAPAN KALUWIN** Professor, University of Papua New Guinea
16:30-17:00	Connecting Users' Needs for Climate Information with Climate Services by Using Economic Benefit Evaluation: The Experiences in Chinese Taipei	**DR. HEN-I LIN** Director, Center for Technology Policy Evaluation and Research, Chung-Hua Institution for Economic Research
17:00-18:00	Wrap-up and Discussion	
18:30-20:30	Dinner hosted by PNG Ministry of Education, Research, Science and Technology	

Thursday August 23, 2018

09:00-12:00	**SESSION IV** Wrap-up and Panel Discussion	
09:00-09:30	Session I Wrap-up	**PROF. SIMON S. Y. WANG** Associate Professor, Utah State University
09:30-10:00	Session II Wrap-up	**DR. JONG AHN CHUN** Research Fellow, APEC Climate Center
10:00-10:30	Session III Wrap-up	**PROF. CHALAPAN KALUWIN** Professor, University of Papua New Guinea
10:30-10:45	Coffee Break	
10:45-12:00	Panel Discussion	**Chaired by PROF. ALBERTO TROCCOLI** World Energy & Meteorology Council
12:00-12:20	**CLOSING CEREMONY**	**PROF. DONGIN LEE** Chairman of Board of Trustees, APEC Climate Center
12:00-12:10	**PROF. DONGIN LEE** Chairman of Board of Trustees, APEC Climate Center	
12:10-12:20	**MR. SAMUEL MAIHA** Director, PNG National Weather Service	
12:20-13:20	Luncheon	

附錄 2　APCC 工作小組報告內容





附錄 2　APCC 工作小組報告內容(續 1)

CWB' s expectation on APCC in 2017

- Could the 6-month forecast be provided earlier ?
  - We appreciate Dr. Daeun Jeong provides the MME forecasts 3 days earlier.
    - But sometimes the link would fail and didn't work….
- Could the 850 hPa wind fields be included in the 6 months forecast?
  - Not yet. It depends on the model providers. APCC can only provide information provided by the model providers.
- The BSISO forecast are usual 1 to 5 days delay depending on different models, could those be provided earlier (less delay)?
  - Again. It depends on the update frequency of data provided.
- Are the 3rd week and the 4th week forecasts available from APCC?
  - Not yet.

4

CWB' s expectation on APCC in 2018

- CWB will continue to develop numerical models to participate in the BSISO and Seasonal MME projects.
- CWB would like to learn the techniques of downscaling and multi-model ensemble from APCC.
- CWB expect APCC to lead the discussion on seasonal forecast through video conference. This will allow the scientists, of APCC members, who interest on the subject can participate in the discussion and learn through internet.

5

Future Collaboration

- CWB appreciate APCC to provide the opportunity to make contribution to the 2018 APEC Climate Symposium.
- CWB will cohost the 3rd APCC MME Model Providers' Meeting in Chinese Taipei (2019) with APCC.

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附錄 2　APCC 工作小組報告內容(續 2)

Acknowledgement

- CWB appreciate APCC (especially Dr. Hae Jeong Kim) to provide the opportunity to participate in 2018 APCC S2S training program.
- CWB expect to have the opportunity to participate in the coming 2018 APCC Downscaling training program.

2018 APCC Downscaling Training Program

I Announcement for 2018 APEC Climate Center Downscaling Training Program

The **APEC Climate Center (APCC)** is hosting a training program with the subject of ***User-oriented Statistical Downscaling of Climate Change Scenario for Agriculture and Water Resources*** from October 15th to 20th to be held in Busan, Korea and is now accepting applications until Friday, 31st August, 2018 KST. The 1-week training program aims to provide an introduction to statistical downscaling for climate change scenarios, and to guide participants in applying the produced data to the fields of agriculture and water resources.

The program will be taught by a highly qualified and diverse team of scientists and will consist of theoretical and practical components. Participants who successfully complete the training program will receive a certificate of completion. The airfare, accommodation and meals will be supported by APCC.

I Period & Venue

- Monday 15th - Saturday 20th, October 2018 / APEC Climate Center, Busan, the Republic of Korea

I Topic

- Title: User-oriented Statistical downscaling of Climate Change Scenarios for Agriculture and Water Resources *The detailed contents of the program are subject to change*

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附錄 3　APCC 工作小組會議紀錄

2018 APCC Working Group Meeting
Date & Time: 22 August 2018 14:00 – 16:00
Location: #216-217 , International Convention Center, Port Moresby, Papua New Guinea

Participants:

1. (Chair) Mr. Samuel Maiha (Director, National Weather Service, Papua New Guinea)
2. Mr. Kasis Inape (Research Assistant, Bureau of Meteorology, Australia)
3. Dr. Enrique Garrido Segovia (Deputy Director, Dirección Meteorológica de Chile, Chile)
4. Dr. Tien-Chiang Yeh (Director-General, Central Weather Bureau, Chinese Taipei)
5. Mr. Joko Budi Utomo (Deputy Director of Applied Climate Information Service, Indonesian Meteorological Climatological and Geophysical Agencies, Indonesia)
6. Mr. Yoshiaki Sato (Senior Coordinator for Climate Modeling, Japan Meteorological Agency, Japan)
7. Mr. Kuh Hee Cho (Deputy Director of Climate Policy Division, Korea Meteorological Administration, Republic of Korea)
8. Dr. Ahmad Fairudz Jamaluddin (Meteorological Officer, Malaysian Meteorological Department, Malaysia)
9. Ms. Edna Juanillo (Weather Services Chief, Philippine Atmospheric, Geophysical and Astronomical Services Administration, the Philippines)
10. Dr. Songkran Agsorn (Deputy Director-General, Thailand Meteorological Department, Thailand)
11. Mr. Le Thanh Hai (Deputy Director General, Viet Nam Meteorology and Hydrology Administration, Viet Nam)
12. (Co-Chair) Dr. Jin Ho Yoo (Acting Executive Director, APEC Climate Center)
13. Ms. Sangwon Moon (Head of External Affairs Department, APEC Climate Center)
14. Ms. Suhee Han (Project Manager, External Affairs Department, APEC Climate Center), Rapporteur

Observer:

-Mr. Marjuki (Head of Applied Climate Division, Indonesian Meteorological Climatological and Geophysical Agencies, Indonesia)
-Ms. Yunjeong Lee (Action Officer, Climate Policy Division, Korea Meteorological Administration, Republic of Korea)

Agenda

TIME	AGENDA
14:00 – 14:05	Opening by Mr. Samuel Maiha (PNG)
14:05 – 14:10	Self-Introduction by each participant
14:10 – 14:25	**Presentation** Introduction to APCC's activities (by Dr. Jin Ho Yoo, APCC)
14:25 – 14:40	**Presentation** Introduction to APCC's activities – International Cooperation (by Ms. Sangwon Moon, APCC)
14:40 – 14:50	**Presentation** Climate Services in the Chilean Weather Service (DMC) (by Dr. Enrique Garrido Segovia, Chile)
14:50 – 15:00	**Presentation** BMKG Indonesia Applied Climate Services (by Mr. Joko Budi Utomo, Indonesia)
15:00 – 15:10	**Presentation** PAGASA's Climate Products and Services (by Ms. Edna Juanillo, Philippines)
15:10-15:15	**Presentation** Enhancing Collaborations between CWB and APCC (by Dr. Tien-Chiang Yeh, Chinese Taipei)
15:15 – 15:55	**Discussion** *Topic* - Possible collaborations among member economies based on the needs and capabilities of each institution - Other issues to be discussed
15:55 – 16:00	Closing remarks by Dr. Jin Ho Yoo (APCC)

Meeting Minutes

Mr. Samuel Maiha, Chair of the APCC Working Group (WG) meeting 2018, started the meeting by expressing his appreciation on APCC for sharing the climate information and services to the region. He also thanked for facilitating this meeting.

Then, he asked each member for self-introduction. Dr. Jin Ho Yoo, Acting Executive Director of APCC, as a Co-Chair of the meeting, greeted members as well with sincere appreciation of participation. He also pointed out the good relationship to be built among members.

The participants of the WG meeting introduced him/herself: Dr. Ahmad Fairudz from Malaysia Meteorological Department of Malaysia, Ms. Edna Juanillo from Philippine

Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) of the Philippines, Dr. Tien-Chiang Yeh from Central Weather Bureau of Chinese Taipei, Dr. Songkran Agsorn from Thailand Meteorological Department of Thailand, Mr. Le Thanh Hai from Vietnamese Meteorology and Hydrology Services of Viet Nam, Mr. Kasis Inape from Bureau of Meteorology of Australia, Dr. Enrique Garrido Segovia from Chile Meteorological Department, Mr. Joko Budi Utomo and Mr. Marjuki from Indonesian Meteorological Climatological and Geophysical Agencies of Indonesia, Mr. Yoshiaki Sato from Japanese Meteorological Agency of Japan, Mr. Kuh Hee Cho and Mr. Yunjeong Lee from Korean Meteorological Administration of the Republic of Korea, and Ms. Sangwon Moon from APEC Climate Center. Ms. Moon also thanked PNG government and CWB for co-hosting APCS 2018.

Mr. Maiha then asked Dr. Jin Ho Yoo to present the current activities of APCC. Dr. Jin Ho Yoo started the presentation on 2018 APCC activities by introducing the organizational structure. Since 2018, the structure of APCC has changed from 5 departments to 3 departments. Now APCC has Climate Services and Research Department, the biggest department which conducts APCC research and related services. Under the department, there are 5 research teams – Climate Prediction Team in charge of operations, Climate Analysis Team which conducts analysis and supports to APCC's climate operational works, Prediction Research Team where the climate prediction research is conducted, Climate Services Development Team which is dedicated to climate services, and Integrative Climate Research Team to make the link between climate and application sectors. Then, there is Management and Planning Department where 2 teams reside under; Strategic Management Team which deals with planning of APCC's direction and relationship with Korean government; and Administration Team that runs the institution. And there is External Affairs Department with Public Relations Team and the department conducts various outreach projects including annual APEC Climate Symposium. The total number of employees is 76 including 40 Ph.Ds.

Dr. Yoo also pointed out that the previous APCC's activities were about generating climate information using MME (Multi-model Ensemble), SCOPS (Seamless coupled Prediction System), and ISO (Intraseasonal Oscillation) methods in one hand and providing the climate information to various application sectors such as water, agriculture, and disaster management on the other hand. Then, in terms of translating climate information to climate application sectors, tailoring climate information and its feedback play an important role. Also, capacity building programs were a part of them. But due to the strong recommendations from higher government, APCC strengthens its function as a climate hub, which gives more focus on initial mandates established in 2005, climate information part and information service part, and less emphasis on application research. In order to effectively conduct the role of information service, APCC created Climate Services Development team.

In climate prediction part, APCC started its operation system in 2005 and the initial tool has been used for more than 10 years. Therefore, now APCC tries to modernize the system to make it more flexible and fast. The current prediction information is officially released on the 25th of each

month. But with the improved system, we could provide the information earlier than now. Also, due to the different hindcast period of each model, APCC hopes to change the MME system more flexible to reflect those changes. APCC conducts research to provide more information such as ENSO strength and drought forecast in global scale. Another part of prediction research is to develop forecast guidelines, which will enable the graphic information more readable by users. Subseasonal forecast is recently a big issue in climate research. APCC started BSISO, Boreal Summer Intraseasonal Oscillation, forecast since 2013. Operational BSISO uses 5 models currently and it could be related to extreme events (rain and temperature), Monsoon onset, and TC (tropical cyclone) genesis. APCC is technically operating WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble (LC_LRFMME), which was designated to the KMA. For the program, APCC receives data from ECMWF and conducts analysis of model outputs to find the optimal way of MME in the subseasonal scale. One announcement is that the S2S ICO (International Cooperation Office) may be hosted by APCC from 2019. This means APCC would gather much more S2S data worldwide.

Tailoring climate information is to make better quality information for better use. It has two aspects; calibration and downscaling. Usually climate forecast information has low resolution such as 5-degree which is not really usable in a specific region. In terms of calibration, it needs knowledge on model performance and biases and climate variability affecting region of interest. Also in order to use climate information in the interested region, spatially and temporally downscaled data is required. APCC develops and uses weather generator to do the downscaling. One example is PICASO (Pacific Island Countries Advanced Seasonal Outlook), particular example for the Pacific Islands. It provides station-wise calibration tool of MME forecast with 3-month rainfall using specified version of CLIK (Climate Information Tool Kit APCC has developed) and detailed user interface only targeted the Pacific Islands. Here the regional characteristics of strong ENSO dependence and predictability have been considered. Dr. Yoo then introduced some of the services APCC provides. CLIK is web-based climate information toolkit which provides customized multi-model ensemble prediction with verification and statistical downscaling tool for your interested region. This requires your specific knowledge on the region. The tool is available via APCC website. The other one APCC newly developed is AIMS (APCC Integrated Modeling Solution) which is also available from the website. It is a user interface platform for climate downscaling and application modeling. It is aimed to downscale mostly climate change scenario and seasonal forecast and then convert the data suitable to application models. So far, this system is only available through software that could be downloaded from the website and installed in the individual computer by users. But the online service will be available through the website soon. Other services such as CLIK and ADSS have also improved its functions and usability. CORDEX-ESGF node is expected to be available at the end of this year.

Although the number of application researches has been reduced since the organizational change, APCC still continues some climate application researches. One example is

groundwater management project for the Pacific Islands Countries where the groundwater is the main source of water resources. In this project, APCC provided the integrated monitoring – modeling – management in groundwater management in Tonga. In rain-fed region in Lao PDR, APCC contributed in rice management by providing seasonal forecasting information which would help farmers plan the crop production. Also, APCC is conducting a study regarding occurrence of marine species due to seawater temperature increase to identify which species are in risk of extinction. By doing application research for some years, APCC has found, with first-hand experience, the interaction with end-users is of much importance to make the climate application research and information practically used. But with limited resources in APCC, it became certain that APCC cannot focus on many application sides but rather focus on some of the example studies. Also, from the years of experience, APCC staff, ourselves, is still faced with gaps in climate side and application side to use proper climate information to the application fields. Therefore, APCC is putting more efforts internally to develop tools or methods for better use of climate information.

Dr. Yoo finalized his presentation by bringing up a topic of the systematic collaboration of APCC Working Group members. Currently, the members collaborate with APCC in terms of capacity building mostly, which is one time event. Dr. Yoo suggested building more productive relationship among members such as creating a plan to raise fund or exchanging human resources for longer period to benefit APEC region. For example, the members could start from monitoring extreme events and regionally optimized climate forecast. Globally optimized forecast set is generated by APCC whereas users would not need globally focused information. Research is needed in order to create regionally optimized information and the members could collaborate towards co-developing the regional climate products and services. Given the fact that APCC is a Korean government funded organization which was established by the endorsement of APEC member economies, APCC has responsibility to contribute the Korean society and international community. And with the collaboration among members, more interactive and effective products and services would benefit both Korea and APEC region.
After Dr. Yoo's presentation, the Chair opened floor for questions and himself asked regarding CLIK's accessibility. Dr. Yoo answered the tool is general tool and everyone can access and run once sign-in to the system.

Dr. Ahmad Fairudz Jamaluddin from MMD asked that, since there are many tools and methods already available in the region and globally, how and what extent we could collaborate.

Dr. Yoo answered firstly by stating that we need to avoid duplication as Dr. Jamaluddin pointed out. There are many tools available in the world using seasonal forecast such as CPT, CLIK, and so on. Those targets are the same but the methods are different. Therefore, we could collaborate starting from combining (or identifying) the advantages and weakness of the existing tools.

Dr. Jamaluddin's second question about the S2S, and Dr. Yoo answered that even though the topic of S2S is booming worldwide, it is still in the research stage. The community uses weekly forecast up to 6 weeks or 8 weeks as to be considered subseasonal forecast. The big drop of predictability skill happens in 3rd week or 4th week of forecast. In terms of the relationship with extreme events, the subseasonal forecast does not aim to predict directly when the next storm hits. But the possibility or risk of storm could be predicted in some range. He also mentioned that there are many initiatives all around the world including CORDEX operated by Malaysia, and suggested, as a group, discuss possible collaboration among them.

Mr. Maiha appreciated Dr. Yoo for the presentation and the floor for quick question and answer. He suggested more collaboration points would be discussed later after the presentations and invited Ms. Sangwon Moon for the presentation on introduction of international collaboration programs.

Ms. Sangwon Moon, Head of External Affairs Department of APCC, started the presentation by reminding one of the given functions of APCC as 'helping build the capacity of member economies in producing and using reliable climate predictions.' She requested for the attention on APCC's capacity building programs from members since less applications have been received from member economies compare to the number of applications from non-APEC economies in recent years.

Ms. Moon introduced Young Scientist Support Program (YSSP) and short-term Training Program as competition-based and CLIK Training Workshop as requested program from the NHMS of each economy. In general, APCC targets the applicants from officer and/or researcher in government agencies primarily in "travel eligible APEC economies" namely Chile, China, Indonesia, Malaysia, Mexico, Papua New Guinea, The Philippines, Peru, Russia, Thailand, and Vietnam. If there are not many applications from those economies, then APCC extends screening the applications from ASEAM member states, Pacific Island Counties, and other developing countries. However, APCC would like to support more participants from APEC economies.

Then, Ms. Moon introduced details of Young Scientist Support Program including the applicable research topics, documents to be submitted, the restrictions, and how the program runs. In 2018, APCC invited 9 participants in total. She also introduced short-term Training Program including topics and target participants. The program is conducted mostly twice a year, and the second training program of 2018 will be held 20 15 - 20 October. The deadline of the application submission is by 31st August and Ms. Moon encouraged all the members to share this information within the organization and through their network. Then, CLIK Training Workshop was introduced. The program is 3-day training workshop hosted in partner organization to use CLIK system and to utilize the outcomes from the system. This program is only hosted based on the request from the organization. There would be CLIK Training Workshop in Vietnam Meteorology and Hydrology Administration in October this year.

She concluded her presentation again by encouraging members to share the capacity building program information within the organization so that good qualified candidates from the member organizations could apply and participate in the programs.

The Chair then invited Chile for the presentation on the climate services of Chile. Dr. Enrique Garrido Segovia, Deputy Director of Dirección Meteorológica de Chile (DMC), first thanked APCC for the invitation to the meeting and Papua New Guinea for their kind hospitality. Dr. Segovia started his presentation to share the challenges of climate services in Chile. He introduced the characteristics of Chile with total area of 756,625 Km2, length of 4,200 Km, and main exports of copper and wine. Chile is unique country in a sense of having long and narrow territory with great variety of climates. Therefore, understanding the climate factors is very important to understand the related economic activities.

He stated that DMC, faced with the various climate scenarios, decides to promote the implementation of climate services, assimilating the new GFCS (Global Framework on Climate Services) by identifying the needs of users, developing integrated climate products, establishing working links with other related organizations, and implementing a new functional structure.

In this aspect, DMC adopted new methodologies as producing climate scenarios using ensemble models, and producing seasonal forecast. DMC specially appreciates APCC's training program since their team is consisted of the program participants and that the team now produces 3 month seasonal forecast along the nation. Also there are classical products such as climate bulletin, drought bulletin, climate index monitoring. And now DMC needs to update the climate services by interacting with other organizations for improving climate services.

The collaborated project with Chile, Colombia, and Peru, called ENANDES (Enhancing Adaptive Capacity of Andean Communities through Climate Services), was introduced as enhancing adaptive capacity of ANDEAN communities through climate services. The project is consisted of 4 steps; improving operational capacity, implementing the national framework of climate services, participating with users, and strengthening regional cooperation.

Dr. Segovia stated that DMC is working at an initial stage for the implementation of a National Framework for Climate Services, and in next 3 year, the process would be finalized. Then it is necessary to strengthen the interaction with users and other related organizations, and then improve the implementation of new specific climatic products. And finally sharing experiences with other Meteorological Services is an effective tool to help the implementation process of climate services.

Dr. Segovia ended his presentation by stating to see all of members in Chile for next year's APEC Climate Symposium. Mr. Maiha thanked Dr. Segovia and invited Mr. Joko Budi Utomo for the next presentation by Indonesia. Mr. Joko Budi Utomo, on behalf of BMKG (Indonesian Meteorological Climatological and Geophysical Agencies), started the presentation on Indonesian's applied climate services. The applied climate information services of BMKG includes 6 sectors; sectoral early warning system, agriculture and water management sectors,

renewable energy, air quality, climate field school program, and public and community based climate literacy.

In 2016, BMKG changed the structure of Climate division. There are two centers related to climate; one is Climate Change Information Center where climate variability is dealt, and the other is Applied Climate Service Center where provides climate service for sectors. BMKG also uses CLIK for customized MME prediction with verification and compare with other model results. For the deterministic verification, MME result is better in East Indonesia in JJA and DJF. But in probabilistic verification, MME has better skill than single models.

Mr. Utomo also shared examples where climate service is used in water management, early warning system for flood and drought, and agriculture sector with collaboration with Ministry of Agriculture. Climate Field School (CFS) for farmers is one of the successful climate change adaptation techniques to increase climate literacy and proven to increase harvesting up to 30 %. Then, BMKG applied CFS to fisheries group.

The Chair thanked Mr. Utomo for the presentation and invited Ms. Edna Juanillo from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) for the climate products and services in the Philippines.

Ms. Edna Juanillo introduced the structure of PAGASA with 2 support division, 5 main divisions, 5 regional service divisions, and field stations. Climatology and Agrometeorological Division (CAD) where Ms. Juanillo is belonged has 4 sections, which Ms. Juanillo will explain in details through this presentation.

PAGASA publishes climate statistics such as normal, extremes, TC summaries, climatological maps and posters. Also climate impact assessment bulletins are issued for agricultural sector which is regularly provided to the clients. There are regional forecast quick look, which is 9-day weather outlook for farm operations, farm weather forecast and advisories, TC warning for agriculture, and 10-day regional agri-weather information provided by PAGASA for sectoral use.

Mr. Juanillo shared the methodologies and procedure for the issuance of climate advisories and forecasts. Firstly having local and synoptic systems for rainfall and temperature analysis, the global numerical model data is also collected such as IRI, NOAA, JMA, KMA, BOM, and WMO. Then, the division produces a draft of forecast, revises based on the comments through forum discussion and consultation, and then provide final output to end-users.

The climatological and meteorological products are introduced; monthly weather situation and outlook, seasonal climate outlook, ENSO advisory, press releases, specialized climate forecast tailor-made for clients specifications, and climate projections and scenarios.

For seasonal climate outlook, PAGASA provides PAYONG PAGASA, a simplified version of outlook, to the local news and press. While monthly weather situation and outlook are issued normal month, ENSO advisory is issued when ENSO event occurs. The simplified version of ENSO advisory is also produced and provided. Drought/dry condition maps and advisory is

issued to the companies of electricity and fertilizer. Then, when onset of monsoon is determined, the press statement is released.

Then, how PAGASA communicates with user groups for climate information was explained. It is with an end to end approach. PAGASA considers agriculture and water sectors as primary users and provide climate information through National Disaster Risk Reduction Management Council (NDRRMC) where, then, disseminates climate information to top-level decision makers, regional offices, provincial offices, and municipal affected communities. And, PAGASA conducts training of trainers through climate field schools (CFS), Agriculture Training Institute of the Department of Agriculture, in-house training programs in PAGASA, and more. Also, monthly climate outlook forum is conducted to interact with users.

Ms. Juanillo stated that the way forward is to improve impact-based forecasting approaches through R&D activities, to develop user-oriented impact based forecast through building partnership, and to conduct regular massive information education campaign to prepare user with the new warning system.

Mr. Maiha thanked Ms. Edna Juanillo for the presentation and invited Dr. Tien-Chiang Yeh, Director-General of Central Weather Bureau (CWB) of the Chinese Taipei for his comments on enhancing collaborations between CWB and APCC.

Dr. Tien-Ching Yeh stated that CWB is a model provider to APCC' s Seasonal and BSISO forecasts system. And he also stated that CWB has received many benefits from APCC including forecast guidance which is used as one of the supports CWB provides to Water Resource Agency in the decision-making of Drought Emergency Team from 2018. From the WG meeting in 2017, CWB asked APCC that 6-month forecast be provided earlier and APCC provides MME forecast 3 days earlier than the original schedule. CWB also requested for 850hPa wind field in 6 month forecast and 1 to 5 days earlier release of BSISO forecast, however, it has been possible until now because it depends on the individual model schedule.

Dr. Yeh listed a few expectations from APCC that CWB would like to continuously join the BSISO and seasonal MME projects of APCC, since CWB would like to learn more about the techniques of downscaling and MME. CWB also proposed APCC to lead the discussions on seasonal forecast through video conference.

Dr. Yeh appreciated that APCC provided an opportunity to CWB researcher to attend 2018 APCC S2S training program and to 2018 APEC Climate Symposium. And he finally stated that CWB hopes to have the opportunity to send one scientist attending the upcoming 2018 APCC downscaling training program, and that looking for more participations in APCC' s programs including co-hosting the 3rd APCC MME Model Providers' Meeting in Chinese Taipei in 2019. Then, Mr. Maiha again thanked all the presenters and opened the floor for discussion on collaborations. He firstly shared that Indonesia has assisted Papua New Guinea for drought monitoring for last few months. And based on the presentations, Chile, the Philippines, Indonesia, and Chinese Taipei have ideas on more collaboration among members and with APCC. In terms of APCC' s capacity building programs, with members' contribution, the applicants from

APEC economies could be increased in next program. He also suggested having trainees present during the APEC Climate Symposium for opportunity' s sake.

Ms. Edna Juanillo suggested following up on the young trainees to share their work and researches in a form of publications so that it can be shared. Also, there is regular climate outlook forum among the Philippines, Indonesia, Singapore, and Malaysia. The next one would be held in Malaysia and this is monthly meeting for 3 month forecast. Here PAGASA is expected to provide climate bulletin to be shared. This type of collaboration could happen among members. Mr. Marjuki from Indonesia stated that APCC training is now focusing on how to produce climate information and he hopes, in the future, the training focuses on sectoral use of climate information.

Dr. Songkran Agsorn from Thailand Meteorological Department asked APCC to lead discussions in seasonal forecast forum, which can be done via video or internet with lively discussion among participants. Also, he stated in Thailand, water management is a big issue especially in rainy season. Therefore, he suggested firstly downscaling in watershed scale, and second interacting with water management sectors would greatly help Thailand for better climate information use.

Dr. Jin Ho Yoo appreciated the comments and he suggested responding few of them. As Ms. Edna Juanillo pointed out, the follow-up activities are important to make the outcome of Young Scientist Support Program (YSS) more practically useful and encourage young trainees to continue the research after going back to their home institutions. Journal publication could be one of good follow-up activities but it also requires sufficient time, additional process and efforts. In the meantime, APCC could share the research outcomes as a form of technical papers when the participants submit their final report. If the research topic and outcome are considered to be appropriate items which would benefit both organizations, it could be more developed by APCC and/or home institution. These kinds of follow-up activities, he believed, would motivate the participants more and make the program more practically beneficial.

Dr. Yoo also admitted that, as Mr. Mrjuki suggested, APCC receives similar comments on expanding training topics to application sectors and climate services. APCC has initially started with climate prediction and producing information, and therefore, we have focused on those parts. However, with many requests from outside and as seen from the presentations today, it is certain that all of us move towards the same direction where climate services take a great part, APCC would prepare for such trainings as well.

As for the comments on video conference on seasonal forecasting, even though it would be difficult to host offline meeting every month, it would be possible to have online meetings. Therefore, he asked to give APCC some time to figure out how to arrange such meetings. With the current tasks, arranging such meetings would be a new additional task for the team, and therefore considering the work distribution and resources, there should be a careful decision on the task.

Dr. Yoo also commented on the watershed scale forecast. In fact, the upcoming training program in October is for the watershed downscaling. AIMS (APCC Integrated Modeling Solution) is user interface platform for climate downscaling and application modeling and the issues on the watershed scale forecast will be covered during the training program. He suggested nominating applicants to the program.

Mr. Maiha highlighted that, from the discussion and comments, there are new important requirements for the new generations of climatologists to have climate and application knowledge altogether. And he emphasized the important of supporting young scientists, and asked if there is any way to enhance the support for early career scientists through APCC's program.

Dr. Yoo agreed that the new generations of climatologists are not only rely on the traditional climate knowledge but understand it more in order to enhance the service. But he also pointed out that since there are still huge gaps in using climate information in various sectors, climatologists should be able to correctly translating climate information, which requires the basics of traditional knowledge. Therefore, the good climatologists would need traditional knowledge and on top of that, need another level of communication and understanding skills in various climate sensitive sectors. He also admitted that he does not know how to develop such skills, but with sharing the experiences, for example how Chile does for climate service, we may find the way.

Mr. Yoshiaki Sato from the Japan Meteorological Agency asked the relationship between APCC and KMA in international level and Dr. Yoo answered that APCC is legally independent organization but most of the direction and working area is under KMA while the focus area is different.

Dr. Jamaluddin from Malaysia asked if APCC could provide MME prediction earlier than usual since MMD hopes to use the data. But the current release time is too late for Malaysia's operation schedule.

Dr. Yoo explained that APCC receives the model data from individual providers until the middle of the month and then goes into pre-processing. It would be around 20th of a month when finishing all the data processing, and then, the result is delivered. After the modernization of the system, APCC could shorten the release period. However, it is important to have enough number of model data to conduct the MME. Dr. Yoo also stated that he would firstly figure out the earliest period when APCC receives 4 or 5 model data collectively for initial processing so that, at least, a subset of data could be released initially for those who are in need.

Dr. Yoo also mentioned that, in terms of dynamical downscaling, APCC is conducting a project with PAGASA to support dynamical downscaling system and it has not been easy since it takes much more time and computation resources than expected and there are many processes which require time and efforts. Once the project is concluded as a successful and doable case, APCC would consider the next similar project.

Dr. Yoo answered the comments from JMA by stating that the brief meeting minutes of APCC Science Advisory Committee (SAC) meeting would be shared once it is available. But for

the information, APCC does not have a SAC meeting for the year of 2018 due to the internal circumstances. It is expected to hold a SAC meeting early next year and the brief meeting minutes could be shared to the Working Group. Also, there are regular Board of Trustees Meetings but the agenda of meeting is mainly about the APCC' s administrational issues in Korea. Therefore, APCC would share the brief minutes of SAC meeting if there is any meaningful result for the WG members.

Ms. Moon added that the APEC hosting economy of the next year is Chile and therefore next WG meeting is likely to be held in Chile. During the APEC PPSTI meeting which was held previous week of the symposium, Ms. Moon discussed with the APEC delegates from Chile that APCS to be held as one of the APEC meeting series next year. Ms. Moon also mentioned that APCC will closely work with DMC for hosing next year' s event.

Mr. Maiha, as the Chair of APCC WG meeting 2018, officially closed the meeting by appreciating APCC and all the members for participation.