

出國報告（出國類別：開會）

# 赴美國參加次季節至季節預測應用研討會

服務機關：交通部中央氣象署

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派赴國家：美國

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## 摘要

為提升短期氣候監測及預警能力，中央氣象署（以下簡稱本署）海象氣候組洪景山組長、羅資婷科長及林昀靜助理研究員前往美國氣候預報中心

（Climate Prediction Center，CPC）參加由美國國家海洋和大氣總署（National Oceanic and Atmospheric Administration，NOAA），美國國家氣象局（National Weather Service，NWS）及科技及技術整合辦公室（Office of Scientific and Technical Information，OSTI）所舉辦「NOAA 次季節至季節預測應用研討會」，此會議目的為加強氣候模式開發人員、使用者/利害關係人和研究人員之間的合作，加速和推進美國下一代次季節及季節模式的研發和作業進程。

本署於會議共發表 3 篇論文：「東亞氣候系統於次季節及季節預報模式中的預報能力」（The evaluations of climate systems in East Asia using S2S forecast）、「臺灣第一週、第二週降水預報的統計後處理」（Statistical Post-processing of Week-1 and Week-2 Precipitation Forecasts Over Taiwan）、「中央氣象署的機率決策支援服務」（Implementation of Probabilistic Impact-based Decision Support Services (IDSS) in the Central Weather Administration）。

此行除了至美國氣候預報中心，亦前往夏威夷與夏威夷大學王斌教授、李天明教授及陳宇能教授針對次季節及季節預報，以及中尺度氣象研究合作進行交流，更進一步瞭解國際季節預報發展趨勢，以提升本署在短期氣候監測、預警及中尺度氣象研究合作的能力。

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## 壹、 目的

美國國家氣象局（National Weather Service，NWS）及科學技術整合辦公室（Office of Scientific and Technical Information，OSTI）正在與聯合預報系統（Unified Forecast System）合作，發展下一版的次季節全球系集預報系統（Global Ensemble Forecast System，GEFS），並開發新一代的季節預報系統（Seasonal Forecast System，SFS）取代了已有十多年歷史的氣候預報系統（Climate Forecast System V2，CFSv2）。OSTI 將組織一系列年度研討會，以支援未來 4 年 GEFS 和 SFS 的研發和作業進程，本次「NOAA 次季節和季節性應用研討會」為第一場次，由美國國家海洋和大氣總署（National Oceanic and Atmospheric Administration，NOAA），美國國家氣象局及科技及技術整合辦公室共同舉辦。研討會的目標是透過加強模式開發者、使用者/利害關係人和研究人員之間的合作來加速和推進 GEFS 和 SFS 的發展。氣象署和美國 NWS 有密切的合作關係，美國 CFSV2，或者下一版本的 SFS 系統，也是本署氣候預報作業的重要指引，爰此，本署由洪景山組長、羅資婷科長及林昀靜助理研究員前往美國氣候預報中心（Climate Prediction Center）參與此次會議，於會中與模式開發者及美國學界研究人員透過交流討論，促進本署與美國氣候預報作業單位及學研單位合作的可能性。

其次，此行亦順道前往夏威夷大學，與王斌教授、李天明教授及陳宇能教授針對次季節及季節預報，以及中尺度氣象研究合作進行交流，更進一步瞭解國際季節預報發展趨勢，以提升本署在短期氣候監測、預警及中尺度氣象研究合作的能力。

## 貳、 過程

本次由本署海象氣候組洪景山組長、羅資婷科長及林昀靜助理研究員赴美參加於美國華盛頓州氣候預報中心舉行的「NOAA 次季節至季節預測應用研討會」，詳細議程請參考附錄 1。此次研討會中本署有 3 篇海報論文發表如附錄 2 至附錄 4，回程至夏威夷大學，與王斌教授、李天明教授及陳宇能教授針對次季節及季節預報，以及中尺度氣象研究合作進行交流，更進一步瞭解國際季節預報發展趨勢，以提升本署在短期氣候監測、預警及中尺度氣象研究合作的能力。

本次行程安排及工作摘要如下表 1：

日期	地點	工作摘要
113年9月2日	臺北-美國	啟程，赴華盛頓州（當日19:37到達美國華盛頓州杜勒斯機場）
113年9月3日至 113年9月6日	美國華盛頓州	參加美國海洋暨大氣總署次季節和季節應用研討會並與美國氣候預測中心人員交流討論
113年9月7日至 113年9月9日	美國夏威夷州	至美國夏威夷大學參訪
113年9月10日 至 113年9月11日	美國-臺北	回程（美國時間9月10日13:00返臺，臺灣時間9月11日23:20抵臺）

表 1 行程安排及工作摘要

### 一、 NOAA 次季節至季節預測應用研討會簡介

為了次季節全球系集預報系統(GEFS)的升級以及新一代季節預報系統(SFS)的開發，NOAA/NWS/OSTI 舉辦了一系列的研討會，以支持 GEFS 和 SFS 在未來 4 年模式的研發和作業進程，該系列研討會的第一場研討會在 2024 年 9 月 4 日至 6 日於馬里蘭州大學公園市的 NOAA 氣候預報中心舉行。

SFS 發展計畫從 2023 年 10 月開始，模式將著重在陸地、海洋和海冰緩慢變化的過程，以捕捉關鍵的次季節及季節尺度現象，例如聖嬰南方振盪現象(ENSO)、季內振盪 (MJO)、季風及極端事件的強度和頻率。第一版的 SFS 系統將在 2028 年上線作業，用以取代已有十多年歷史的氣候預報模式系統 (CFSv2)，預期會在降水、乾旱、溫度、熱帶氣旋頻率和極端天氣的季節性預報方面有重大進展。

本次研討會的目標是在增進模式發展、使用者和研究人員之間的合作，以加速和推進 GEFS 和 SFS 的發展，將來自多個部門的科學家和利益相關者聚集在一起，解決下列關鍵主題，包括 (1) NOAA 次季節和季節模式 (GEFS、SFS) 的需求、(2) 預報員如何應用次季節和季節模式、(3) 北美多模式預報 (North American Multi-Model Ensemble, NMME) 的系統性偏差，以及 (4) 改進次季節和季節模式系統的經驗/見解、(5) 新版次季節全球系集預報系統 (GEFSv13) 的開發和實施方面的進展、(6) NOAA 的 SFS 發展計畫以及開發 SFSv1 的早期結果，以及 (7) 人工智慧方法於次季節和季節預報應用等。完整的議程及簡報可參閱附錄 1。



圖 1 研討會與會人員大合照。

## 二、 研討會演講摘錄

以下摘錄幾場演講的重點整理：

### 1. 次季節至季節預報研究對於行動的重要性

美國 NOAA 首席科學家 Dr. Sarah Kapnick 指出，幾十年前，科學家由簡單的

模式了解聖嬰及季內振盪等可預報度的來源，而隨著科學演進發展至今，目前在次季節至季節預報中，統計模式、動力模式及人工智慧模型均可以提供甚至改善預測技術，次季節至季節預報可以被廣泛運用並減少生命受損的風險，也可以增加創新和生產力。在研究中已可證明，冬季的聖嬰展望可以推動金融市場減少數十億的風險，在美國的各州次季節至季節預報產品也可以應用在水資源管理及農業應用來滿足基本需求及生存需要或者支持能源安全，在非洲，我們可以應用次季節至季節預測針對高溫乾旱和糧食安全提供資訊。全球面臨氣候變遷而增加了需求和急迫性，發展健全的次季節至季節預報科學，並建立可操作的次季節至季節預報產品為當務之急

## 2. ECMWF 次季節和季節預報系統的研究與發展（邀請演講）

歐洲中期天氣預報中心（European Centre for Medium-Range Weather Forecasts，ECMWF）的 Dr. Magdalena Balmaseda 介紹目前 ECMWF 次季節和季節性預報系統的現狀，以及正在進行的研究與發展。現有的模式中有一些可改進的地方，包含較弱的遙相關，東印度洋偏冷等，現在嘗試著提高海洋模式的解析度、改進海洋和陸地的初始化方法，以及應用機器學習等提升預報技術。特別提到於赤道東太平洋海溫有偏暖的趨勢，導致影響到聖嬰的預報，從 2020 年至 2022 年連續 3 年反聖嬰年的預測，東太平洋海溫均反應過暖的偏差，導致無法預測反聖嬰的發展。另外，以 2023/24 聖嬰事件發展的預測，說明季節預報在 18 個月以上有預報技術，在 2025 年即將產出的季節性預報，SEAS6（Seasonal Forecasting System）將會每年提供 2 次 25 個月的預測。總結目前的研究、實務作業、以及下一代的季節性預報系統 SEAS6 的發展，可以綜整以下重點 1) 次季節和季節尺度預報在氣候變遷中越來越重要；2) 長期存在的模式誤差限制了預報能力，因此需要尋求替代的方案，例如機器學習等的後處理方式；3) 持續的針對預報系統進行評估，並導入新的診斷方法、預報指標等；4) 利用已有的經驗針對預報系統進行持續

的改善；5) 使用者需要 1-2 年的預報，以填補季節至年代際間預報的缺口。

### 3. ECCC 的季節預報：成功、挑戰和經驗

ECCC (Environment and Climate Change Canada) 為加拿大環境和氣候變遷中心，Dr. Bill Merryfield 分享 ECCC 從 1990 年代開始所發展的每一代氣候預報系統都是使用多模式多系集的策略，報告中也根據模式與系集數量進行預報能力的分析，結果顯示不論是模式或系集數的增加都會使預報能力提升，其中又以增加模式的數量後預報能力提升的程度較明顯。今年 7 月上線的 CanSIPsv3 預報系統是採用 CanESM5 加上 GEM5.2-NEMO，預報產出為 2 個模式，每一個模式各 20 個系集成員，雖然多模式的預報能力較好，但是要維持多模式的運作以提供預報產出為一大挑戰。

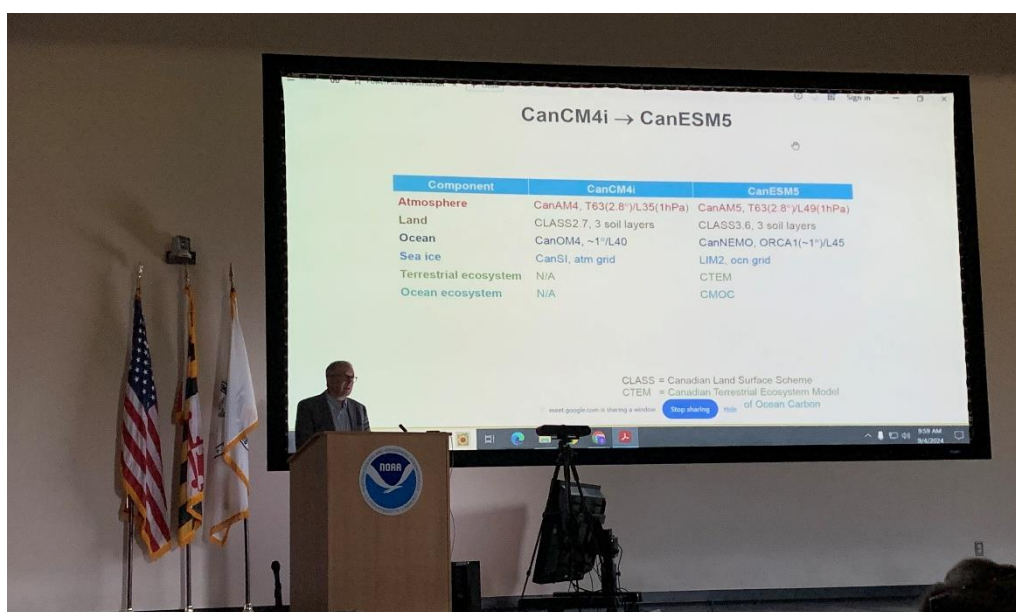


圖 2 邀請演講：ECCC Dr. Bill Merryfield 分享加拿大氣候預報系統。

### 4. 與次季節至季節模式 (GEFS 和 SFS) 應用需求相關演講

- (1) NOAA/NWS 分析與預報部門 (Analysis and Forecast Branch) 的 Dr. Young-Joon Kim 介紹分析與預報部門主要的工作是收集預報員對於模式預報



的需求，透過發展評估流程轉化為對模式發展的要求。為分析使用者對此模式的需求以及對 SFS 的發展做準備，在 2024 年初，針對 NOAA 及非 NOAA 的使用者對於 GFS 及 GEFS 的使用回饋進行調查，同時也收集 CPC 預報員的意見，這些需求會透過發展評估流程傳達給模式發展者，以滿足使用者在 S2S 模式應用上的需求。

- (2) NWS 氣候服務計畫已提供國家、區域和地方的氣候服務超過 20 年，並透過使用者調查、研討會、合作等方式增進服務。NOAA/NWS 分析與預報部門的 Dr. Marina Timofeyeva 介紹未來 NWS 在氣候服務的規劃，除了在氣候觀測、監測、預報的持續改進外，還包含了納入多重時間尺度的氣候預報產品（從極端事件到氣候變遷）、NWS 服務領域與社會挑戰的應用（包含火災、乾旱、雪情、沿海洪水等）、氣候訊息傳遞與決策（氣候服務操作文件、客製化定量氣候資料），這些主題必須透過與分析與預報部門合作以及 NWS 發展評估流程、建立在 S2S 的模式發展需求上。
- (3) NOAA/NWS/NWC（National Water Center）為水資源決策提供預測和展望，包含數小時至數月的可用水量，NWC 的 Dr. Royce Fontenot 分享目前 NWS 透過 GEFS-forced Hydrologic Ensemble Forecast System（HEFS）模式提供 3-6 個月的季節性水文預報、或是透過 CFS-forced National Water Model（NWM）的水文模式提供長期預報，但由於各界對於水文預報的需求為跨小時到季節的時間尺度，因此 NWC 目前正在發展 S2S 預測產品和服務以滿足使用者的需求，但由於水文模式需要各種時間尺度的雨量輸入資料，且為定量值而非機率，因此對於 S2S 模式的在不同時間及空間解析度的預報輸出為一大挑戰。
- (4) 乾旱是影響美國損失最慘重的天災之一，準確的 S2S 乾旱預報對於減

輕乾旱相關影響和成本相當重要。NOAA/CPC 的 Dr. Hailan Wang 分享，目前美國乾旱產品的開發在很大程度上依賴次季節和季節性動力模型（如 GEFSv12 及 NMME 等），因此容易受到模式預報能力的影響，目前在乾旱發展的挑戰包含 1) 預報在降水和溫度的預測能力有限，導致對乾旱發展的預報能力也有限；2) 地表初始條件的準確性不足，3) 模式預報輸出的變數有限，缺乏某些計算乾旱指數所需要的變數，因此這部分 CPC 透過驅動地表模式來產生這些地表變數，4) 在目前模式預報的溫度及降水存在十年趨勢方面的問題，5) 事後預報期間長度的適合性，是否有能力判斷氣候變遷對十年或更長時間尺度的乾旱，6) 乾旱類型的客觀判斷，7) 最終產品的視覺化及應用及使用者在理解機率乾旱預報方面所面臨的挑戰。

- (5) USNIC (US National Ice Center) 為 3 個政府單位的組織，包含 US Navy、NOAA/OPC (Ocean Prediction Center)、US Coast Guard，提供全球及軍事上在雪、冰的預報及決策分析，其中 NNOA/OPC 提供包含風、波浪的海洋天氣預警和預報。NOAA/NCEP/OPC 的 Dr. Logan Dawson 分享，由於 OPC 和 USNIC 的責任範圍涵蓋北半球中緯度地區和兩極區，因此極度依賴全球數值天氣預報系統以及遙測平台的資訊，模式在海冰、風、波浪和冰的預報對於跨洋航運、極地航線在通知開關穿越北極和五大湖的航運路線相當重要，目前 OPC 使用 GEFSv12 發展第二周的海洋風浪機率預報，但在 GEFSv12 較長的預報時間尺度上缺乏完整的大氣-海洋、波浪-冰、波浪-海流間的交互作用，極端浪高的預報能力等，因此在 S2S 模式的預報需求上需要在模式的耦合中加入與風暴加劇、波浪和湧浪生成等相關的大氣-海洋相互作用，以在模式中突顯出極端條件及偏差校正等。

- (6) NOAA/NMFS (National Marine Fisheries Services) Dr. Howard Townsend 的

報告提到關於 S2S 在海洋生物資源的管理，包含漁業管理、水產養殖、受保護物種到棲息地保護、次季節到季節的海洋預測，以及 NOAA 氣候、生態系統和漁業決策輔助系統（Climate, Ecosystems and Fisheries Initiative, CEFI），CEFI 系統使用氣候、海洋和生態系統模式，在不同的預報時間尺度提供未來可能發生的情境，讓管理和決策者可以掌握未來可能發生狀況，以做好準備和應對。

- (7) 離岸風電廠 C2Wind 的 Dr. Rémi Gandoin 在報告中指出目前風能工程和其科學應用上經常使用再分析資料，但在再分析資料提供者和風能科學家之間的知識傳遞與溝通仍然是缺乏與不協調的，因此在近期的 International Energy Agency Topical Expert Meeting #111 目標為建立風能與全球/區域再分析間的連結、並提出風能和電力系統使用者對 NOAA 下一代再分析資料的需求，由於 CFSv2 再分析資料可以比擬 ERA5，而且沒有強烈的風速偏差，因此特別建議不要淘汰 CFSv2。
- (8) 目前在美國風力發電已達到與燃煤發電和核能發電相當的能源供應量，但風力發電的可用性受季節至年際尺度的氣候振盪影響甚大，因此能源系統規劃和運作需要相當有能力的季節風能預測。NOAA/OAR/GFDL（Geophysical Fluid Dynamics Laboratory）的 Dr. Xiaosong Yang 在報告中分享使用 GFDL 的 Seamless System for Prediction and Earth System (SPEAR) 季節性預測產品評估美國本土風力發電的季節性預報技術，結果顯示出冬季能源的預報表現相當突出，其可能與 ENSO 的逐年變化影響到風的大尺度配置有關，因此 SPEAR 的季節性風能預測能力對於使用能源的高峰季節相當重要。
- (9) NOAA/OAR/GSL（Global Systems Laboratory）Dr. Stan Benjamin 在報告中分享，NOAA 和 CDC（Centers for Disease Control and Prevention）合作研究

溫度和降水異常與西尼羅河病毒（WNV）住院病例之間的關係，利用GEFS、SFS和國際上S2S預報模式的資料，針對美國地區/縣尺度建立周/月尺度的WNV預測模型，成果相當不錯，未來將規劃降尺度預報到更小的區域尺度，並應用天氣預報產品，以縮短預報的時間尺度。

- (10) NOAA/NOS（National Ocean Service）Dr. John Callahan提到NOS每個月提供HTF（High Tide Flooding）展望，是根據約100個潮汐測量點的天文潮汐預測、海平面趨勢、海平面持續性月距平和氣候非潮汐殘差，產生未來一年的洪水預報，過去研究顯示此方法在預測洪水的發生已有相當的預報技術。目前正在發展將S2S的預報加入HTF中，因此需要更多關於海平面氣壓、風向/風速、降水量、海洋溫度、鹽度、洋流等的變數。
- (11) NASA/GSFC/SAIC（Science Applications International Corporation）的Dr. Kristi Arsenault在報告中提到NASA使用Land Information System（LIS）地表模式和水文架構開發Global Hydro-Intelligence Subseasonal-to-Seasonal（GHI-S2S）系統，以提供次季節到季節時間尺度上的水文氣象預報，利用NMME及CFSv2資料可產出時間長度達9個月的水文氣象預報，若此系統應用於S2S上，其需求將包含：需要足夠長度的事後預報資料、小於 $1^{\circ} \times 1^{\circ}$ 的空間解析度、以及除了溫度/降水外更多的變數預報場等。
- (12) 氣象預報結果需要先進行統計後處理後才用作為水文模型的輸入，不同的統計後處理方法適合用在不同時間尺度的氣象預報結果，NOAA/PSL（Physical Sciences Laboratory）的Dr. Mimi Abel的報告提到他們在S2S時間尺度上開發了一種針對降水預報進行重新取樣的統計後處理方法，作為水文模型的輸入以驅動流量預報，且適用在任何S2S的預報產品。

## 5. 次季節至季節預報應用經驗相關演講

- (13) Dr. Mike DeFlorio在報告中提到Center for Western Weather and Water Extremes (CW3E)針對美國西部的水文氣候變量開發了一套實驗性的次季節和季節性預報產品(包含未來2至4週大氣河活動及強度的展望等),模式中可以提早掌握在2022/12至2023/01從加州登陸的9條大氣河,其帶來的水氣緩解了當時美國西部地區的嚴重乾旱,因此此實驗性預報產品對美國西部的水資源管理相當有助益。
- (14) CPC Operational Prediction Branch的主管Dr. Jon Gottschalck在報告中提到CPC負責NWS的官方氣候作業,發布的產品和服務涵蓋次季節到季節時間尺度,包括溫度、降水、極端事件/災害、乾旱、熱帶氣旋以及影響這些的氣候特徵(例如ENSO、MJO等)。CPC針對S2S提供橫跨多重時間尺度的監測與預報展望,在決策管理上相當重要,但與天氣預報相比,S2S需更多仰賴動力模式的預報結果,接下來會加入人工智慧技術在模式開發和後處理過程中、機率型預報產品的應用/視覺化等。
- (15) 在動力模式中影響季節預報能力的兩個關鍵因素為海溫長期趨勢和ENSO的變化,NOAA/NWS/NCEP/CPC的Dr. Wanqiu Wang針對CFSv2中模式的海溫長期趨勢和ENSO變化做了校驗,發現赤道東太平洋海溫有偏暖的預報,且在目前發展的SFS模式中也有類似的情形。另外也針對可能會影響次季節預報的季內振盪(MJO)進行診斷,季內振盪強度偏弱且速度慢,在GEFSv13模式中表現較GEFSv12及CFSv2較佳。可以從模式的表現探討,可能造成誤差的原因以改進及提高SFS的預報表現。
- (16) NOAA/NWS/NCEP/WPC (Weather Prediction Center) Dr. David Novak在報告中提到極端降水在氣候暖化的情形下更加劇,但過去幾十年間NOAA

在模式降水預報上改進幅度微小，尤其在次季節到季節的時間尺度上，模式很難正確的預報到降水距平值，但使用者的需求卻不斷增加，超出目前的可預報能力，因此NOAA制定了一項改進中尺度到季節尺度的降水預報策略，稱為NOAA Precipitation Prediction Grand Challenge (NOAA PPGC)，為了顯著提高降水預報的準確性和可信度，PPGC在S2S上期待達到的目標包含對太平洋上的大氣-海洋動力機制的了解、MJO預報能力的精進、廣泛使用人工智慧技術及3-4週降雨預報服務的提升。

## 6. 本署發表的論文簡介

本研討會中，本署於會議共發表 3 篇論文：「東亞氣候系統於次季節及季節預報模式中的預報能力」(The evaluations of climate systems in East Asia using S2S forecast)、「臺灣第一週、第二週降水預報的統計後處理」(Statistical Post-processing of Week-1 and Week-2 Precipitation Forecasts Over Taiwan)、「中央氣象署的機率決策支援服務」(Implementation of Probabilistic Impact-based Decision Support Services (IDSS) in the Central Weather Administration (CWA))。針對所發表的 3 篇論文摘要如下：

在「東亞氣候系統於次季節及季節預報模式中的預報能力」海報中，主要是針對東亞季風、颱風及季內振盪等氣候系統，評估 GEFS 及 ECMWF 展期模式的預報能力，以東亞季風來說，模式約於 2 至 3 週前有預報能力，颱風則以 2 週內預報技術較佳，而針對季內振盪，則以聖嬰發展年較正常年及反聖嬰年預報技術較佳。

在「臺灣第一週、第二週降水預報的統計後處理」海報中，旨在透過貝氏模型平均法 (Bayesian Model Average, BMA) 發展適用於臺灣地區的客觀綜合後處理 (Objective Comprehensive Post-Processing, OCP) 方法，包含偏差校正、統計降

尺度、整合預報，建置綜合多模式多系集預報資訊之雨量季節預報模型，提供月季雨量機率預報指引。另外，由於跨領域單位對預報空間解析度的需求增加，在統計後處理的架構上發展高解析度格點(1 km)機率預報產品，未來可針對農業、林業、水資源領域客製化產生極端降水或乾旱指標供預報決策參考。

在「中央氣象署的機率決策支援服務」中主要是提供如何在預測不確定性下做出最佳決策的解決方案，在本研究中使用美國全球系集預測系統(GEFS)的資料，運用降尺度技術生成高解析度、且經過良好校準的機率預測，指導用戶如何在不確定性下應用預測資訊。最後，也提供一個量身訂製的決策支持工具，能夠提供機率預測和決策資訊。此外，通過經濟價值分析來量化和評估機率預報的價值，是當前和未來的重點。

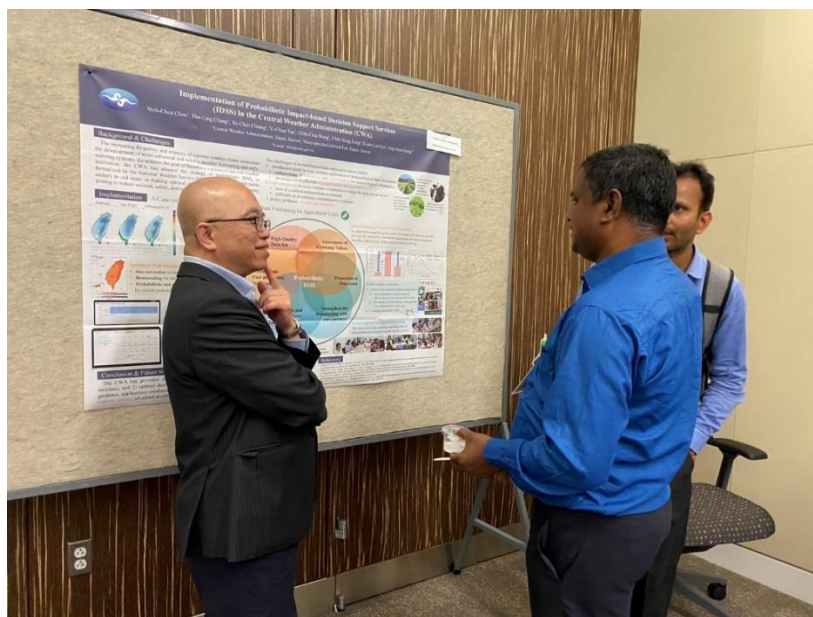


圖 3 洪景山組長於海報前與 NOAA/NWS/NCEP/CPC 人員進行討論。

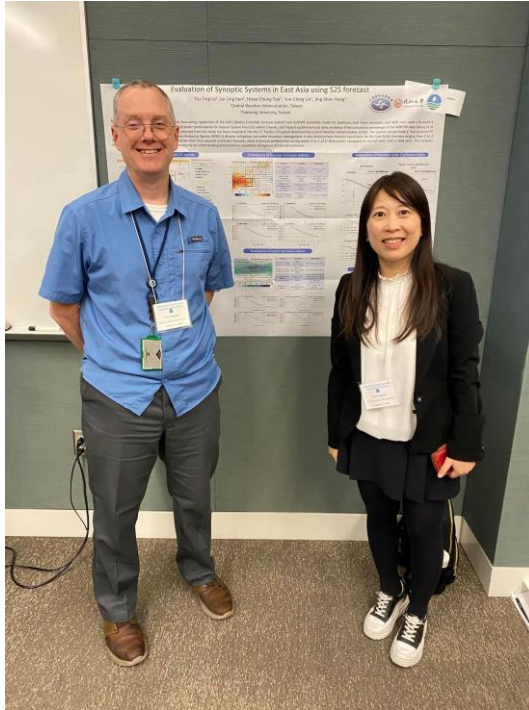


圖 4 羅資婷科長與 NOAA/NWS/NCEP/CPC Dr. Cory Baggett 於張貼海報前合影。



圖 5 與 NOAA/NWS/NCEP/CPC 的主管 Dr. David Dewitt 合照。





圖 6 與 NOAA/NWS/NCEP/CPC Dr. Wassila Thiaw 合照。



圖 7 與 NOAA/NWS/NCEP/CPC Dr. Jon Gottschalck 合照。

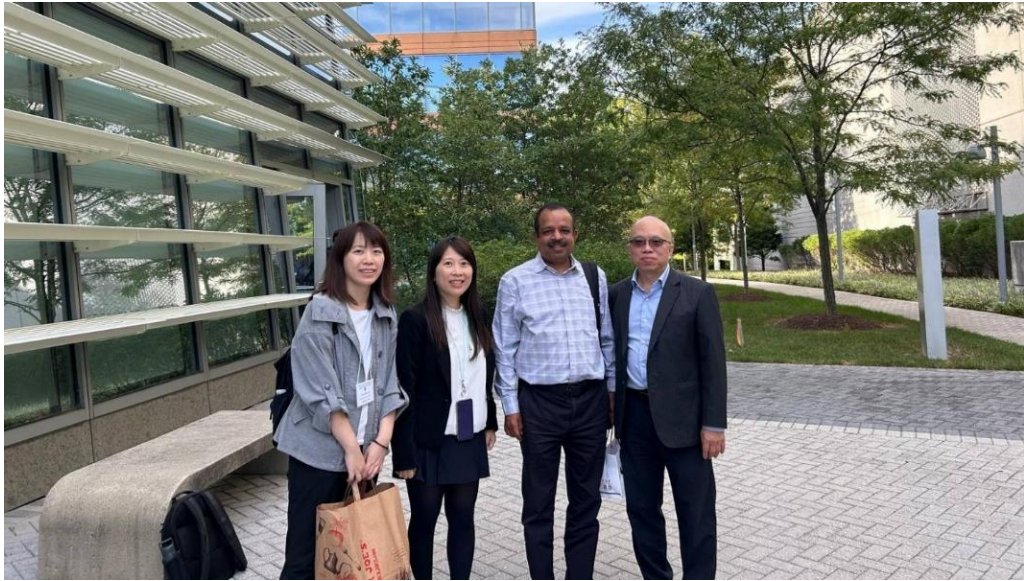


圖 8 與 NOAA/NWS/NCEP/EMC Vijay Tallapragada 合照。

### 三、 夏威夷大學參觀訪問

為強化氣象署在氣候及中尺度氣象研究的國際連結，在本次的訪問中拜訪夏威夷大學，主要分成兩個部分。第一是訪問夏威夷大學氣象系的王斌和李天明教授，兩位教授在氣候領域學有專精，並且和氣象署有超過 20 年的合作關係。本年度王斌教授主動邀請本署郭芮伶助理研究員前往該系進行移地研究，此次訪問活動包括 1. 分享與討論郭芮伶助理研究員的工作成果，並進行相關討論。2. 研議未來合作的方向，包括人員互訪、月季預報指引技術的研發，以及運用人工智慧技術在氣候預報的可能合作議題。

陳宇能教授是梅雨研究及地形效應的專家，在與陳宇能教授的會議中，主要是針對高層冷心低壓對午後對流的影響進行經驗交流。臺灣在夏季常因高層冷心低壓移入，導致熱力不穩定的大氣結構，並又發劇烈的對流活動。陳教授也在夏威夷發現類似的個案，雙方針對此一現象進行廣泛的交流。此外，陳教授也分享他在去年美國夏威夷州茂宜島爆發嚴重火災的個案，有關東北信風如何受地形影響導致極端風速，並助長火災的蔓延，同時也簡要說明夏威夷在防救災作為上的可能缺失。最後，我們也分享臺灣和夏威夷使用高解析度波浪和海流模式預報在海岸遊憩與海岸安全的應用現況，以及可能的發展方向。最後，我們期待彼此在美國大氣科學研究中心（NCAR）所發展之 MPAS/JEDI 資料同化系統，能有更進一步的研發合作。



圖 9 拜訪夏威夷大學「國際太平洋研究中心」。

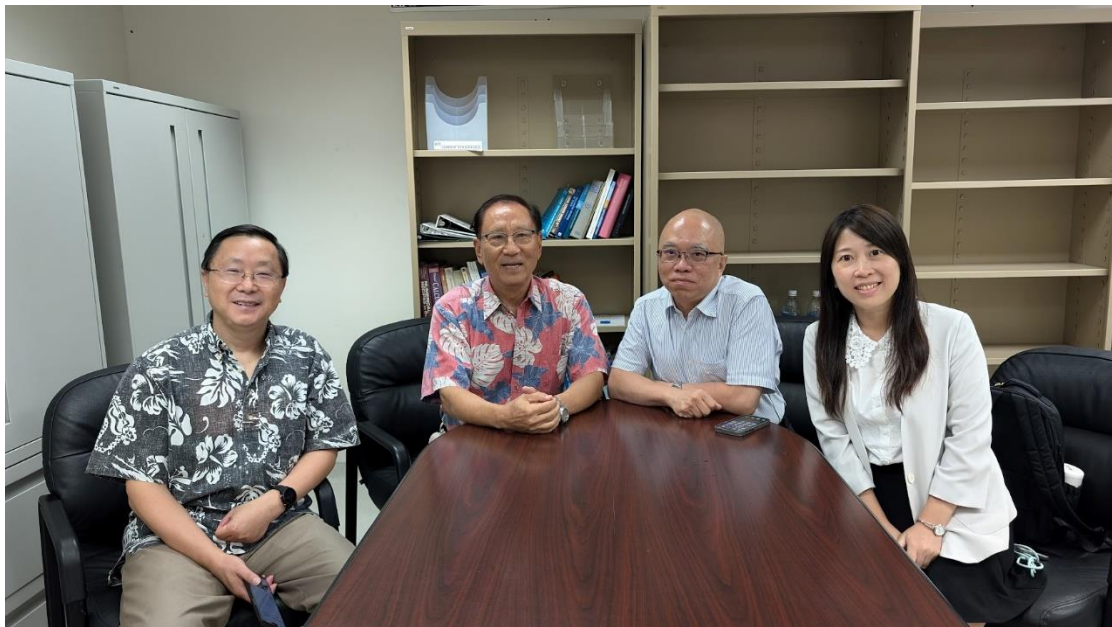


圖 10 拜訪夏威夷大學王斌和李天民教授研究團隊，洽談氣候研究合作事宜。



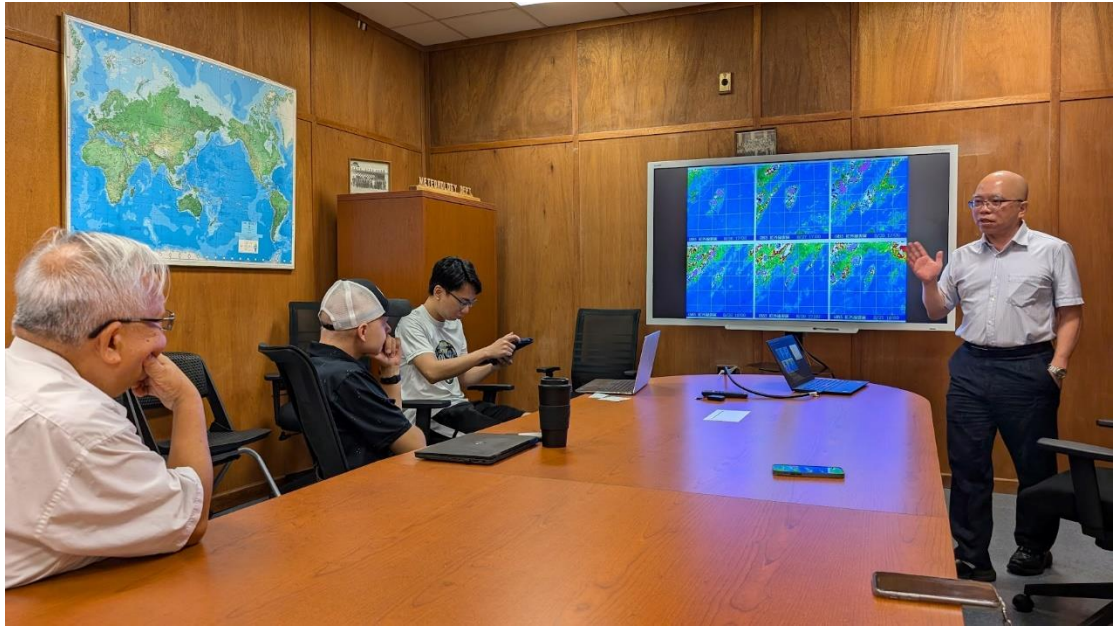


圖 11 拜訪夏威夷大學陳宇能教授研究團隊，討論中尺度科學研究合作事宜。

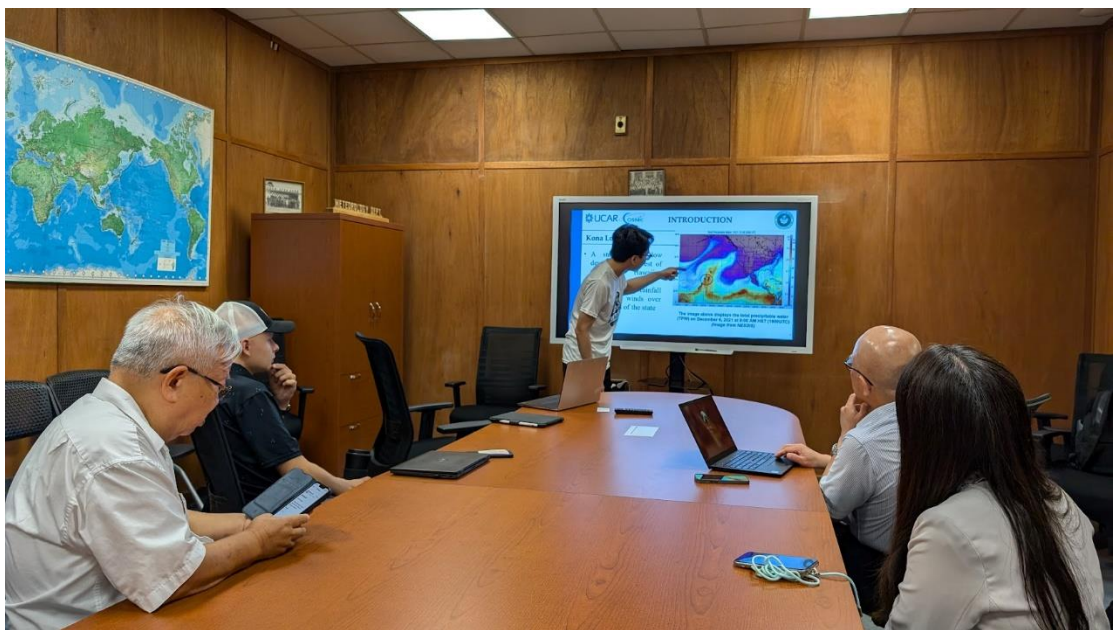


圖 12 拜訪夏威夷大學陳宇能教授研究團隊，討論中尺度科學研究合作事宜。

## 參、心得與建議

綜合此次活動過程之觀察心得與建議如下：

- 一、 模式發展方面，目前美國季內預報系統 GEFS 作業版本為 v12，GEFSv13 預計於 2026 年第 1 季上線，此外也開始投入資源發展季節預報系統 SFSv1，本次會議也介紹歐洲及加拿大模式的發展歷程，可發現不同國家的模式目前也都仍面對不少挑戰，但面對挑戰的過程中，仍持續透過了解模式目前所面對的問題，進而找出解決方案，而改進模式的預報。本署季節模式 CWACFSv2，於今（2023）年上線作業，經由東亞區域的校驗評估，表現不亞於歐洲模式，可吸取國外模式改進的經驗，持續發展本署模式，未來透過國際交流，將本署預報提供給美國氣候預報中心參考。
- 二、 在參與此次的研討會當中，了解到許多不同領域，包含水文、農業、海洋、電力、流行病等各領域對於次季節至季節預報資料的需求及其應用層面，目前氣象署在與水文、農業、林業、漁業等跨領域單位皆有相當密切的合作，未來我們也會與公衛等更多單位有進一步合作的機會，並針對這些合作單位提供無縫隙的預報產品，並積極的將氣候預報資訊傳遞並教育使用者，在因應未來氣候變化的不確定性增加時，可以提前制定策略、做好調適。
- 三、 在 COVID-19 疫情之後，氣象署和美國 CPC 已經多年沒有直接的合作關係。CPC 負責美國的短期氣候預報作業，其政府角色定位和氣象署的海象氣候組是一致的。美國擁有先進的氣候預報技術及氣候服務經驗，但也面臨氣候變遷威脅、人工智慧技術的挑戰，以及新一代模式發展的轉型等，藉此次研討會和 CPC 所有的領導管理人員和主要的科學家重新建立聯繫關係，同時也邀請明(2025)年來臺訪問，這對於後續

拓展本署和美國 CPC 的合作關係，會是一個重要的里程碑，本署也將掌握此一契機持續拓展國際合作關係，持續提升預報技術，及拓展各領域的氣候服務。

# 附錄 1：「次季節至季節預測應用研討會」

[NWS OSTI](#) / [OSTI Modeling](#) / [Events](#) / [2024](#) / NOAA's Subseasonal and Seasonal Applications Workshop



## NOAA's Subseasonal and Seasonal Applications Workshop

Toward Increasing Collaborations among Users, Modelers and Researchers  
September 4-6, 2024



[Meeting Home](#) [Agenda](#) [Poster Sessions](#) [Organizing Committee](#) [SFS Development Plan](#)

### Agenda | 2024 NOAA's Subseasonal and Seasonal Applications Workshop

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**Day 1: Wednesday, September 4, 2024**

**Oral Sessions: 8:30am - 2:30pm, Auditorium**

Time	Session/Title	Chair/Presenter	Presentation
<b>8:00 - 8:30 AM</b> Registration (pickup name-tags) and coffee/snack			
<b>8:30 - 10:10 AM</b> Recording Part 1: <a href="https://www.youtube.com/watch?v=0Na36VjeqE4">https://www.youtube.com/watch?v=0Na36VjeqE4</a> Recording Part 2: <a href="https://www.youtube.com/watch?v=LQd8Nug4XeM">https://www.youtube.com/watch?v=LQd8Nug4XeM</a> <i>Note: Some recordings are not available and/or had A/V issues during recording</i>			
<b>8:30 - 8:42 AM</b>	Introduction and Logistics of the Workshop	Yan Xue, NOAA/NWS/OSTI Modeling Program	<a href="#">PDF</a>
<b>8:42 - 8:47 AM</b>	Opening remarks	Kevin Garrett, Director of NOAA/NWS/OSTI /Modeling Program	<a href="#">PDF</a>
<b>8:47 - 8:52 AM</b>	(virtual) Opening remarks	Jessie Carman, Chief of NOAA/OAR/WPO/Earth System Research and Modeling Division (virtual)	<a href="#">PDF</a>
<b>8:52 - 10:10 AM</b> S2S modeling and prediction challenges and opportunities Chair: Yan Xue			
<b>8:52 - 9:00 AM</b>	Importance of S2S Research to Operations	<a href="#">Dr. Sarah Kapnick, NOAA Chief Scientist</a>	<a href="#">Recording</a>



9:00 - 9:30 AM	<a href="#">Research and developments for the ECMWF subseasonal and seasonal forecasting systems</a>	<a href="#">Magdalena Balmaseda, ECMWF (Invited keynote)</a>	<a href="#">PDF</a>
9:30 - 10:00 AM	<a href="#">Seasonal forecasting at ECCO: Successes, challenges and lessons learned</a>	<a href="#">Bill Merryfield, ECCO (Invited keynote)</a>	<a href="#">PDF</a>
<b>10:00 - 10:10 AM</b> Q & A			
10:10 - 10:30 AM Coffee Break			
<b>10:30 - 12:00 PM</b> Requirements and needs for S2S Applications: Part I Co-Chairs: Mark Olsen, Jason Anderson Recording: <a href="https://www.youtube.com/watch?v=ZpDfe5Hc2Y">https://www.youtube.com/watch?v=ZpDfe5Hc2Y</a>			
10:30 - 10:45 AM	<a href="#">Development of Modeling Requirements for Global Forecast Systems based on Users' Needs Identified from User Feedback - Part I: Background and Introduction</a>	Young-Joon Kim, NOAA/NWS/AFS	<a href="#">PDF</a>
10:45 - 11:00 AM	<a href="#">Building an NWS Climate Services Roadmap: S2S Needs for Building a Climate Ready Nation</a>	Marina Timofeyeva, NOAA/NWS/AFS	<a href="#">PDF</a>
11:00 - 11:15 AM	(Virtual) <a href="#">S2S Forecast Requirements for Hydrologic Forecasting</a>	Royce Fontenot, NOAA/NWS/NWC (virtual)	<a href="#">PDF</a>
11:15 - 11:30 AM	<a href="#">Probabilistic Subseasonal-to-Seasonal (S2S) Forecasts of U.S. Drought: Challenges and Needs</a>	Hellan Wang, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
11:30 - 11:45 AM	<a href="#">Forecaster Priorities and S2S Modeling Needs at OPC and USNIC</a>	Logan Dawson, NOAA/NWS/NCEP/OPC	<a href="#">PDF</a>
11:45 AM - 12:00 PM	<a href="#">S2S forecasts for living marine resource management</a>	Howard Townsend, NOAA/NMFS	<a href="#">PDF</a>
12:00 - 1:30 PM Lunch			
<b>1:30 - 3:00 PM</b> Forecaster's priorities in Improving S2S Applications: Part I Co-Chairs: Cory Baggett, Jieshun Zhu Recording: <a href="https://www.youtube.com/watch?v=5Hn4feQlrE">https://www.youtube.com/watch?v=5Hn4feQlrE</a>			
1:30 - 1:45 PM	(Virtual) <a href="#">CW3E Subseasonal and Seasonal Research, Experimental Forecast Product Development, and Stakeholder Interaction: Applications During Winter 2022-2023</a>	<a href="#">Mike DeFlorio, CW3E/Scripps-University of California San Diego (Invited, virtual)</a>	<a href="#">PDF</a>
1:45 - 2:00 PM	<a href="#">Overview of CPC S2S climate outlooks, applications, challenges and priorities in the context of dynamical model forecast guidance</a>	<a href="#">Jon Gottschalck, NOAA/NWS/NCEP/CPC (Invited)</a>	<a href="#">PDF</a>
2:00 - 2:15 PM	<a href="#">What Improvements are we seeking in the Seasonal Forecast System (SFS) for seasonal prediction products?</a>	<a href="#">Wanglu Wang, NOAA/NWS/NCEP/CPC (Invited)</a>	<a href="#">PDF</a>

2:15 - 2:30 PM	<a href="#">The Weather Prediction Center's Increasing Use of S2S Prediction Tools and Data</a>	Mark Klein NOAA/NWS/NCEP/WPC	<a href="#">PDF</a>
2:30 - 2:45 PM	<a href="#">Subseasonal-to-Annual Net Basin Supply and Water Level Forecasting for the Great Lakes Region</a>	David Wright, NOAA/OAR/GLERL	<a href="#">PDF</a>
2:45 - 3:00 PM	<a href="#">Developing an S2S Forecast System for Predicting US Coastal Inundation Risk</a>	John Albers, NOAA/OAR/PSL	<a href="#">PDF</a>
<b>3:00-3:05pm</b> Group Photo at NCWCP Entrance			
3:00 - 3:30 PM Coffee Break			
<b>3:30 - 5:30 PM</b> <a href="#">Poster Session Part I</a> Co-Chairs: Shira Francis, Jason Anderson			

**Day 2: Thursday, September 5, 2024**

**Parallel Sessions: 8:30am - 5:00pm**

Time	Location	Session/Title	Chair/Presenter	Presentation
<b>8:00 - 8:30 AM:</b> Registration (pick up name-tags) and coffee/snack				
<b>8:28 - 8:30 AM</b>	Auditorium and Conference Rooms B&C	Logistics and Code of Conduct	Shira Francis, Yan Xue	
<b>8:30 - 10:00 AM:</b> <b><i>Parallel Session 8:30am - Auditorium</i></b> Requirements and needs for S2S Applications: Part II Co-Chairs: Jason Anderson, Mark Olsen Recording: <a href="https://www.youtube.com/watch?v=morkyxK_qIY">https://www.youtube.com/watch?v=morkyxK_qIY</a>				
<b>8:30 - 8:45 AM</b>	Auditorium	<a href="#">Next generation NOAA reanalyses: Wind Energy and Power System Modelling user requirements</a>	Remi Gandoin, C2WIND	<a href="#">PDF</a>
<b>8:45 - 9:00 AM</b>	Auditorium	<a href="#">Skillful Seasonal Prediction of Wind Energy Resources in the contiguous United States</a>	Xiaosong Yang, NOAA/OAR/GFDL	<a href="#">PDF</a>
<b>9:00 - 9:15 AM</b>	Auditorium	<a href="#">Building Toward a Weather-S2S-Climate-Informed West Nile Virus Forecast</a>	Stan Benjamin, CIRES/University of Colorado Boulder & NOAA/OAR/GSL	<a href="#">PDF</a>
<b>9:15 - 9:30 AM</b>	Auditorium	<a href="#">Coastal High Tide Flooding Prediction on a Subseasonal to Seasonal Timescale</a>	John Callahan, NOAA/NOS	<a href="#">PDF</a>
<b>9:30 - 9:45 AM</b>	Auditorium	<a href="#">Initializing and Predicting Globally Subseasonal-to-Seasonal Hydrometeorological Extremes</a>	Kristi Arsenault, SAIC & NASA-GSFC	<a href="#">PDF</a>

9:45 - 10:00 AM	Auditorium	<a href="#">Enhancing subseasonal to seasonal ensemble streamflow predictions using post-processed precipitation forecasts to inform resampling</a>	Mimi Abel, NOAA/OAR/PSL	<a href="#">PDF</a>
<b>8:30 - 10:10 AM</b> <b><i>Parallel Session 8:30am - Conference Rooms B &amp; C</i></b> Systematic errors in North American Multi-Model Ensemble (NMME) and other S2S modeling systems and experiences/insights in improving model performance Co-Chairs: Emily Becker, Santha Akella Recording Part 1: <a href="https://www.youtube.com/watch?v=v4hx8sfJcWE">https://www.youtube.com/watch?v=v4hx8sfJcWE</a> Recording Part 2: <a href="https://www.youtube.com/watch?v=Dy3nb-axdbw">https://www.youtube.com/watch?v=Dy3nb-axdbw</a> <i>Note: Some recordings are not available and/or had A/V issues during recording</i>				
8:30 - 8:50 AM	Conference Rooms B & C	<a href="#">Rapid development of systematic trend errors in seasonal forecasts</a>	<a href="#">Jonathan Beverley, NOAA/OAR/PSL &amp; CIRES/University of Colorado Boulder (invited)</a>	<a href="#">PDF</a>
8:50 - 9:10 AM	Conference Rooms B & C	<a href="#">Understanding and improving simulations and forecasts of tropical Pacific climate and ENSO using GFDL's SPEAR models</a>	<a href="#">Andrew Wittenberg, NOAA/OAR/GFDL (Invited)</a>	<a href="#">PDF</a>
9:10 - 9:25 AM	Conference Rooms B & C	<a href="#">Diagnosing the predictability and simulation errors of seasonal extreme heat in the GFDL Seamless System for Prediction and Earth System Research (SPEAR)</a>	Nathaniel Johnson, NOAA/OAR/GFDL	<a href="#">PDF</a>
9:25 - 9:40 AM	Conference Rooms B & C	<a href="#">Seasonal Forecasts of Tropical Cyclones using GFDL SPEAR and HIFLOR-S</a>	Hiroyuki Murakami, NOAA/OAR/GFDL	<a href="#">PDF</a>
9:40 - 9:55 AM	Conference Rooms B & C	<a href="#">Evaluating Linear and Nonlinear bias correction methods in seasonal precipitation forecasts</a>	Bohar Singh, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
9:55 - 10:10 AM	Conference Rooms B & C	<a href="#">Seasonal climate prediction and alternative forecasts in a nonstationary climate based on dynamical models</a>	Dan Collins, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
<b>10:00 - 10:30 AM:</b> Coffee Break Poster Session II <span style="background-color: black; color: black;">■</span> Co-Chairs: Shira Francis, Jason Anderson				
<b>10:30 - 12:00 PM:</b> <b><i>Parallel Session 10:30am - Auditorium</i></b> Forecaster's priorities in improving S2S Applications: Part II Co-Chairs: Jieshun Zhu, Cory Baggett Recording: <a href="https://www.youtube.com/watch?v=4H0kDaj2YU8">https://www.youtube.com/watch?v=4H0kDaj2YU8</a>				
10:30 - 10:45 AM	Auditorium	<a href="#">The NOAA Precipitation Prediction Grand Challenge: Strategy and Ongoing Activities to Improve S2S Precipitation Predictions</a>	David Novak, NOAA/NWS/NCEP/WPC	<a href="#">PDF</a>

10:45 - 11:00 AM	Auditorium	<a href="#">Hybrid Statistical-Dynamical Prediction of the Indian Ocean Dipole</a>	Zewdu Segele, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
11:00 - 11:15 AM	Auditorium	<a href="#">The GEFS model's role in Subseasonal Forecasting of Extreme Heat at the Climate Prediction Center</a>	Evan Oswald, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
11:15 - 11:30 AM	Auditorium	<a href="#">Development of a Skill-based Week 3-4 Precipitation Forecast Consolidation</a>	Lisi Pei, ERT Inc & NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
11:30 - 11:45 AM	Auditorium	<a href="#">Evaluating Bias-Correction Methods for Enhancing Summer Extreme Precipitation Predictions in the U.S. Corn Belt Using CWRE</a>	Guangwei Li, ESSIC/University of Maryland, College Park	<a href="#">PDF</a>
11:45 AM - 12:00 PM	Auditorium	<a href="#">Improving Heatwave Predictions with Machine Learning: Insights from India's Rising Temperature Trends</a>	Harvir Singh, NCMRWF, Ministry of Earth Sciences, India	<a href="#">PDF</a>
<b>10:30 - 12:05 PM:</b> <b>Parallel Session 10:30am - Conference Rooms B &amp; C</b> Best practices in Initializing seasonal forecast systems: Part I Co-Chairs: Jeffrey Whitaker, Elena Shevliakova Recording: <a href="https://www.youtube.com/watch?v=YA6tCJ7I-DE">https://www.youtube.com/watch?v=YA6tCJ7I-DE</a>				
10:30 - 10:50 AM	Conference Rooms B&C	<a href="#">(Virtual) The new ECMWF ORAS6 system and the Impact on Subseasonal and Seasonal forecasts</a>	Hao Zuo, ECMWF (invited, virtual)	<a href="#">PDF</a>
10:50 - 11:05 AM	Conference Rooms B&C	<a href="#">(Virtual) Marine JEDI data assimilation for UFS</a>	Travis Sluka, UCAR/JCSDA	<a href="#">PDF</a>
11:05 - 11:20 AM	Conference Rooms B&C	<a href="#">Global Ocean Reanalysis (GLORe) and its initialized SFS hindcasts</a>	Jieshun Zhu, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
11:20 - 11:35 AM	Conference Rooms B&C	<a href="#">Initialization of Upper Ocean Temperature towards Forecast Improvements in GFSv17</a>	Katherine Lukens, NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
11:35 - 11:50 AM	Conference Rooms B&C	<a href="#">Development of Four-Dimensional Variational Global Ocean Data Assimilation System for Coupled Predictions in Japan Meteorological Agency</a>	Yosuke Fujii, JMA/MRI	<a href="#">PDF</a>
11:50 AM - 12:05 PM	Conference Rooms B&C	<a href="#">GFDL SPEAR Seasonal Prediction System: Initialization and Bias Correction</a>	Felyu Lu, NOAA/OAR/GFDL	<a href="#">PDF</a>
<b>12:00 - 1:30 PM</b> Lunch				
<b>1:30 - 3:00 PM:</b> <b>Parallel Session 1:30pm - Auditorium</b> Process-level diagnostics and evaluation metrics: Part I Co-Chairs: Cristiana Stan, Nathaniel Johnson Recording: <a href="https://www.youtube.com/watch?v=6NIX2HbxxaA">https://www.youtube.com/watch?v=6NIX2HbxxaA</a>				



1:30 - 1:45 PM	Auditorium	<a href="#">Correcting Climate Model Forecasts Based on Forced Autoregressive Models</a>	Timothy DelSole, George Mason University ( <i>Invited</i> )	<a href="#">PDF</a>
1:45 - 2:00 PM	Auditorium	<a href="#">Generating a Flexible Verification System for Precipitation by Assessing Precipitation Skill in the Unified Forecast System (UFS) and North American Multi-Model Ensemble (NMME) via Model Evaluation Tools (METplus)</a>	Johnna Infanti, NOAA/NWS/NCEP/CPC ( <i>invited</i> )	<a href="#">PDF</a>
2:00 - 2:15 PM	Auditorium	<a href="#">An Overview of Subseasonal Verification at the Environmental Modelling Center</a>	Shannon Shields, SAIC & NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
2:15 - 2:30 PM	Auditorium	<a href="#">(Virtual) Subseasonal-to-Seasonal ocean forecasts relevant for marine resource management</a>	Dillon Amaya, NOAA/OAR/PSL ( <i>invited, virtual</i> )	<a href="#">PDF</a>
2:30 - 2:45 PM	Auditorium	<a href="#">Object-Based Evaluation of Marine Heatwave Predictions</a>	Jacob Cohen, University of Washington	<a href="#">PDF</a>
2:45 - 3:00 PM	Auditorium	<a href="#">Evaluation of ocean variability in a 74-year UFS DATM-MOM6-CICE6 simulation</a>	Calhong Wen, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
<b>1:30 - 3:05 PM:</b> <b>Parallel Session 1:30pm - Conference Rooms B &amp; C</b> Best practices in initializing seasonal forecast systems: Part II Co-Chairs: Elena Shevliakova, Jeffrey Whitaker Recording: <a href="https://www.youtube.com/watch?v=gtpe0NMGTBY">https://www.youtube.com/watch?v=gtpe0NMGTBY</a>				
1:30 - 1:50 PM	Conference Rooms B&C	<a href="#">(Virtual) Uncovering the Interannual Predictability of the 2003 European Summer Heatwave Linked to the Tibetan Plateau</a>	Ruby Leung, DOE/PNNL ( <i>invited, virtual</i> )	<a href="#">PDF</a>
1:50 - 2:05 PM	Conference Rooms B&C	<a href="#">Initializing land surface states for SFS</a>	Clara Draper, NOAA/OAR/PSL	<a href="#">PDF</a>
2:05 - 2:20 PM	Conference Rooms B&C	<a href="#">Land Initializations contribute most to the sub-seasonal forecast skill for food and water sectors</a>	Sanjiv Kumar, Auburn University	<a href="#">PDF</a>
2:20 - 2:35 PM	Conference Rooms B&C	<a href="#">Subseasonal prediction skill: role of initialization and land-atmosphere coupling</a>	Jadwiga (Yaga) Richter, NCAR	<a href="#">PDF</a>
2:35 - 2:50 PM	Conference Rooms B&C	<a href="#">Seasonal Prediction skill Improvement of Indian Summer Monsoon: Case Study based on Ocean Initial condition</a>	Samir Pokhrel, Indian Institute of Tropical Meteorology, Pune, India	<a href="#">PDF</a>
2:50 - 3:05 PM	Conference Rooms B&C	<a href="#">Global Data Assimilation System for Aerosols (GDAS-Aero) Version 1 Development</a>	Cory Martin, NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
<b>3:00 - 3:30 PM</b> Coffee Break Poster Session II <span style="background-color: black; color: black;">■</span> Co-Chairs: Shira Francis, Jason Anderson				

<b>3:30 - 5:00 PM:</b> <b><i>Parallel Session 3:30pm - Auditorium</i></b> Process-level diagnostics and evaluation metrics: Part II Co-Chairs: Nathaniel Johnson, Cristiana Stan Recording: <a href="https://www.youtube.com/watch?v=qZWAJAay0To">https://www.youtube.com/watch?v=qZWAJAay0To</a>				
<b>3:30 - 3:45 PM</b>	Auditorium	<a href="#">Assessing Equatorial Pacific Kelvin Wave Response to Westerly Wind Bursts in NCEP/EMC's UFS-based Global Coupled Modeling System</a>	Charlotte DeMott, Colorado State University	<a href="#">PDF</a>
<b>3:45 - 4:00 PM</b>	Auditorium	<a href="#">Process-Level Assessment of Tropical Convective Coupling and Air-Sea Coupling in the UFS</a>	Brandon Wolding, NOAA/OAR/PSL & CIRES/University of Colorado Boulder	<a href="#">PDF</a>
<b>4:00 - 4:15 PM</b>	Auditorium	<a href="#">A Synoptic Climatology of U.S. MJO Impacts in the ERA5 Reanalysis dataset and the GEFsv12 Model</a>	Timothy Eichler, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
<b>4:15 - 4:30 PM</b>	Auditorium	<a href="#">Occurrence of Extreme Events in West Africa and its relationship with the Madden Julian Oscillation</a>	Coumba Niang, Universite Cheikh Anta Diop & Michigan State University	
<b>4:30 - 4:45 PM</b>	Auditorium	<a href="#">Flash drought development in GEFsv12 forecasts: a case study of the 2022 Central US flash drought</a>	Andrew Badger, NOAA/NWS/NCEP/CPC & ESSIC/University of Maryland, College Park	<a href="#">PDF</a>
<b>4:45 - 5:00 PM</b>	Auditorium	<a href="#">Diagnosing drivers of extreme precipitation and corresponding errors in the UFS</a>	Erik Swenson, George Mason University	<a href="#">PDF</a>
<b>3:30 - 4:57 PM:</b> <b><i>Parallel Session 3:30pm - Conference Rooms B &amp; C</i></b> GEFsv13, user requirements and towards development of GEFsv14 Co-Chairs: Avichal Mehra, Neil Barton Recording: <a href="https://www.youtube.com/watch?v=hRPXuGAGj-A">https://www.youtube.com/watch?v=hRPXuGAGj-A</a> <i>Note: Some recordings are not available and/or had A/V Issues during recording</i>				
<b>3:30 - 3:45 PM</b>	Conference Rooms B&C	<a href="#">GEFsv13: status and challenges</a>	<a href="#">Bing Fu, NOAA/NWS/NCEP/EMC (Invited)</a>	<a href="#">PDF</a>
<b>3:45 - 3:57 PM</b>	Conference Rooms B&C	<a href="#">The Office of Water Prediction requirements and use of weather/climate model reforecasts</a>	Mark Fresch, NOAA/NWS/OWP	<a href="#">PDF</a>
<b>3:57 - 4:09 PM</b>	Conference Rooms B&C	<a href="#">New York City's Water Supply Experience in Using HEFS Forecast</a>	Adao Matonse, NYCDWP-Bureau of Water Supply	<a href="#">PDF</a>
<b>4:09 - 4:21 PM</b>	Conference Rooms B&C	<a href="#">(Virtual) Preliminary Evaluation of GEFsv13 EP5r2 Hindcasts and Intercomparison with GEFsv12, ECMWF, and CFS</a>	Robert Long, ERT Corporation & NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
<b>4:21 - 4:33 PM</b>	Conference Rooms B&C	<a href="#">Representation of MJO Variability in the NCEP GEFsv13 Experimental Forecasts</a>	Mingyue Chen, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>

4:33 - 4:45 PM	Conference Rooms B&C	<a href="#">Improvements in week 3&amp;4 ocean forecasts in recent GEFS prototypes targeting GEFSv13</a>	Sulagna Ray, SAIC & NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
4:45 - 4:57 PM	Conference Rooms B&C	<a href="#">Evaluation of the stratosphere in the Unified Forecast System (UFS) prototypes</a>	Laura Clasto, NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
5:30 - 7:30 PM Dinner Option				

**Day 3: Friday, September 6, 2024**

**Oral Sessions: 8:30am - 3:00pm**

Time	Session/Title	Chair/Presenter	Presentation
8:00 - 8:30 AM: Coffee/snack			
8:28 - 8:30 AM	Logistics and code of conduct	Shira Francis	
<b>8:30 AM - 10:00 AM: Advancements in UFS components</b> Co-Chairs: Neil Barton, Avichal Mehra Recording: <a href="https://youtu.be/OzV5ZYIUWvs">https://youtu.be/OzV5ZYIUWvs</a>			
8:30 - 8:45 AM	<a href="#">On Physics Development and Dycore Updates for UFS Applications Including the Seasonal Forecast System</a>	Fanglin Yang, NOAA/NWS/NCEP/EMC (Invited)	<a href="#">PDF</a>
8:45 - 9:00 AM	<a href="#">Enhancing snow parameterizations in Noah-MP land model to improve S2S prediction</a>	Ronnie Abolafia-Rosenzweig, NCAR (Invited)	<a href="#">PDF</a>
9:00 - 9:15 AM	<a href="#">MOM6 Developments Towards CESM3: Advancements, Challenges, and Future Directions</a>	Gustavo Marques, NCAR (Invited, virtual)	<a href="#">PDF</a>
9:15 - 9:30 AM	<a href="#">(Virtual) Developments in coupled wave-sea ice interactions and the consequences for enhancing ice-albedo feedback and the response of sea ice to cyclones</a>	Cecilia Bitz, University of Washington (Invited, virtual)	<a href="#">PDF</a>
9:30 - 9:45 AM	<a href="#">Overview of WAVEWATCH III in the UFS</a>	Jessica Meixner, NOAA/NWS/NCEP/EMC (Invited)	<a href="#">PDF</a>
9:45 - 10:00 AM	<a href="#">Description and Evaluation of the Aerosol Component, based on NASA's GOCART2G, in the Latest Prototype of the Unified Forecast System: Application to the NOAA Global Ensemble Forecast System version 13</a>	Barry Baker, NOAA/OAR/ARL (Invited)	<a href="#">PDF</a>
10:00 AM - 10:20 AM: Coffee Break			
<b>10:20 AM - 11:28 AM: SFS Development Plan and early results in developing SFSv1</b> Co-Chairs: Fanglin Yang, Neil Barton Recording: <a href="https://youtu.be/ShdDDgvrhRI">https://youtu.be/ShdDDgvrhRI</a>			
10:20 - 10:40 AM	<a href="#">The Seasonal Forecast System Development Plan</a>	Phillip Pegion, NOAA/OAR/PSL (Invited)	<a href="#">PDF</a>

Time	Session/Title	Chair/Presenter	Presentation
10:40 - 10:52 AM	<a href="#">Hydrostatic Seasonal Forecast System Development within the Unified Forecast System at NOAA</a>	Xiaolong Zhou, NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
10:52 - 11:04 AM	<a href="#">Improving Forecasts of Surface and Near-Surface Fields in the Seasonal Forecast System through Enhanced Land Surface Physics</a>	Weizhong Zheng, Lynker & NOAA/NWS/NCEP/EMC	<a href="#">PDF</a>
11:04 - 11:16 AM	<a href="#">The Crucial Role of the Initial State in Predicting the MJO Advancement Across the Maritime Continent</a>	Lisa Bengtsson, NOAA/OAR/PSL	<a href="#">PDF</a>
11:16 - 11:28 AM	<a href="#">(Virtual) Hierarchical Testing of Air-sea Interactions in SFS</a>	Weiwei LI, NCAR & DTC	<a href="#">PDF</a>
<b>11:30 AM - 12:30 PM: Community feedback on SFS Development Plan</b> <span style="background-color: black; color: black;">■</span> Co-Chairs: Phil Peglon, Nell Barton			
11:30 - 11:40 AM	Panel Presentation 1	Magdalena Balmaseda, ECMWF	<a href="#">PDF</a>
11:40 - 11:50 AM	Panel Presentation 2	Jim Kinter, George Mason University	<a href="#">PDF</a>
11:50 AM - 12:00 PM	Panel Presentation 3	Randall D. Koster, NASA	<a href="#">PDF</a>
12:00 - 12:30 PM	Open Discussion (In-person and on Slack)		
12:30 PM - 1:30 PM: Lunch			
<b>1:30 PM - 2:30 PM: Workshop Summary</b> Co-Chair: Yan Xue, NOAA/NWS/OSTI Modeling Program Recording: <a href="https://www.youtube.com/watch?v=gO_49SStVms">https://www.youtube.com/watch?v=gO_49SStVms</a>			
1:30 - 1:36 PM	Session summary on Requirements and needs for S2S Applications	Mark Olsen, NOAA/OAR/WPO Jason Anderson, NOAA/NWS/OSTI	<a href="#">PDF Pages 2-3</a>
1:36 - 1:42 PM	Session summary on Forecaster's priorities in Improving S2S Applications	Cory Baggett, NOAA/NWS/NCEP/CPC Jieshun Zhu, NOAA/NWS/NCEP/CPC	<a href="#">PDF Pages 4-5</a>
1:42 - 1:48 PM	Session summary on Systematic errors in North American Multi-Model Ensemble (NMME) and other S2S modelling systems	Emily Becker, University of Miami Santha Akella, NOAA/NWS/NCEP/EMC	<a href="#">PDF Pages 6-7</a>
1:48 - 1:54 PM	Session summary on Best practices in Initializing seasonal forecast systems	Jeffrey Whitaker, NOAA/OAR/PSL Elena Shevliakova, NOAA/OAR/GFDL	<a href="#">PDF Pages 8-9</a>
1:54 - 2:00 PM	Session summary on Process-level diagnostics and evaluation metrics	Cristiana Stan, George Mason University Nathaniel Johnson, NOAA/OAR/GFDL	<a href="#">PDF Pages 10-11</a>



Time	Session/Title	Chair/Presenter	Presentation
2:00 - 2:06 PM	Session summary on GEFSv13, user requirements and towards development of GEFSv14	Avichal Mehra, NOAA/NWS/NCEP/EMC Neil Barton, NOAA/NWS/NCEP/EMC	<a href="#">PDF Page 12</a>
2:06 - 2:12 PM	Session summary on Advancements in UFS components	Neil Barton, NOAA/NWS/NCEP/EMC Avichal Mehra, NOAA/NWS/NCEP/EMC	<a href="#">PDF Pages 13-14</a>
2:12 - 2:18 PM	Session summary on SFS Development Plan and early results in developing SFSv1	Fanglin Yang, NOAA/NWS/NCEP/EMC Neil Barton, NOAA/NWS/NCEP/EMC	<a href="#">PDF Page 15</a>
2:18 - 2:24 PM	Session summary on Community feedback on SFS Development Plan	Phil Peglon, NOAA/OAR/PSL Neil Barton, NOAA/NWS/NCEP/EMC	<a href="#">PDF Pages 16-18</a>
2:24 - 2:30 PM	Workshop report and next steps	Yan Xue, NOAA/NWS/OSTI/Modelling Program	<a href="#">PDF Pages 19-21</a>
<b>2:30 PM - 3:00 PM: Closing Remarks and Awards</b> Co-Chair: Yan Xue, NOAA/NWS/OSTI/Modelling Program Recording: <a href="https://www.youtube.com/watch?v=mrFluqnUvz4">https://www.youtube.com/watch?v=mrFluqnUvz4</a>			
2:30 - 2:35 PM	Poster Session Early Career Awards	Co-Chairs: Cristiana Stan, Elena Shevliakova, Emily Becker	<a href="#">PDF</a>
2:35 - 2:40 PM	Anticipated FY25 Weather Program Office funding opportunities	Mark Olsen NOAA/OAR	<a href="#">PDF</a>
2:40 - 2:50 PM	Closing Remarks	David DeWitt, Director of NOAA/NWS/NCEP/CPC	<a href="#">PDF</a>
2:50 - 3:00 PM	Closing Remarks	Robert Webb, Director of NOAA/OAR/PSL	<a href="#">PDF</a>
3:00 PM: Workshop Adjourned			

## S2S modeling and prediction challenges and opportunities: Keynote Speakers

### Dr. Sarah Kapnick, NOAA Chief Scientist

Sarah Kapnick, Ph.D., is chief scientist for NOAA. In this role, Dr. Kapnick is responsible for advancing policy and program direction for NOAA's science and technology priorities. Dr. Kapnick has extensive experience at the intersection of climate science and economics. Most recently, she served as a managing director at J.P. Morgan in the role of senior climate scientist and sustainability strategist for asset and wealth management. Previously, Dr. Kapnick was a physical scientist and deputy division leader on seasonal to decadal variability and predictability at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL). At GFDL, her work spanned seasonal climate prediction, mountain snowpack, extreme storms, water security and climate impacts.

Dr. Kapnick is a member of the American Geophysical Union, American Meteorological Society and American Association for the Advancement of Science. She received a Ph.D. in atmospheric and oceanic sciences from UCLA, and an A.B. in mathematics from Princeton University.

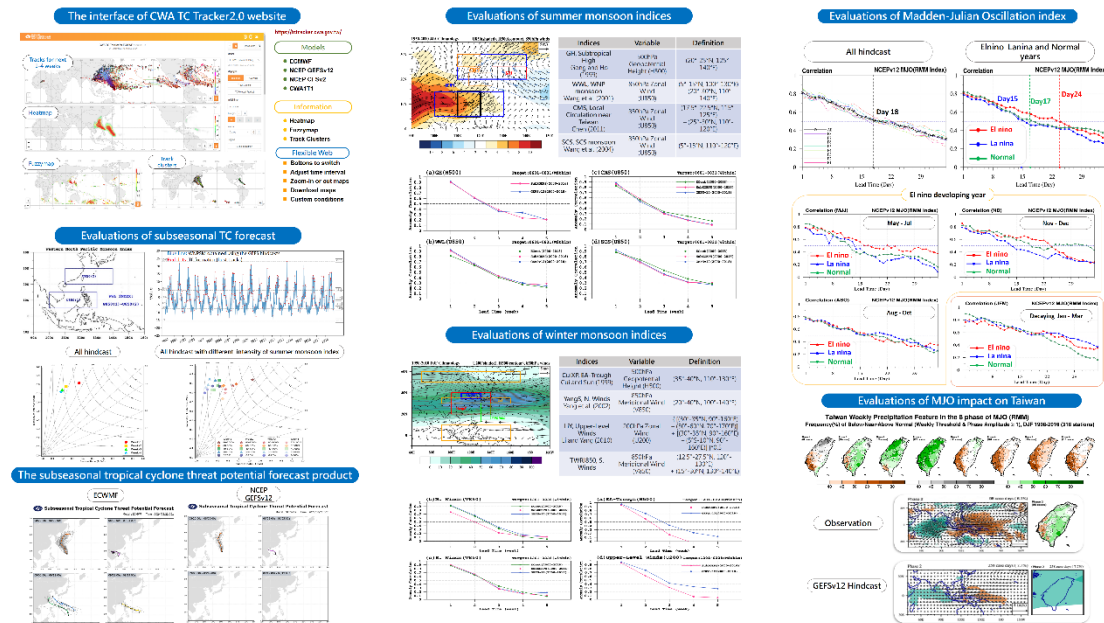
# 附錄 2 海報論文發表：The evaluations of climate systems in East Asia using S2S forecast

## Evaluation of Synoptic Systems in East Asia using S2S forecast

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**Abstract** This study focuses on assessing the forecasting capabilities of the GEFs (Global Ensemble Forecast System) and ECMWF ensemble model for typhoons, East Asian monsoon, and MJO over week-1 to week-4. Preliminary results indicate that the model exhibits better predictability for tropical cyclone forecasts within 2 weeks, and tropical cyclone forecast skills are better if the cumulative percentage of the WNP5M index (Wang et al. 2001) is larger than 60%. The evaluation results obtained from this study has been integrated into the TC Tracker 2.0 system developed by Central Weather Administration (CWA). The system can generate a "Sub-seasonal TC Threat Potential Forecast" product to assist Water Resources Agency (WRA) in disaster mitigation and water resources management. It also demonstrates forecast capabilities for the East Asian monsoon ranging from 2 to 3 weeks in advance. Furthermore, evaluations indicate that intra-seasonal oscillation forecasts show enhanced performance during weeks 2 to 3 of El Niño events compared to normal years and La Niña years. This analysis emphasizes the importance of S2S forecast in enhancing our understanding and predictive capabilities of regional climate phenomenon.



# 附錄 3 海報論文發表：Statistical Postprocessing of Week-1 and Week-2 Precipitation Forecasts Over Taiwan

## Statistical Postprocessing of Week-1 and Week-2 Precipitation Forecasts Over Taiwan

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### Motivation

The predictability of precipitation is hindered by fine-scale processes not captured explicitly in global numerical models, such as convective interactions, cloud microphysics, and boundary layer dynamics. However, there is growing demand across various sectors for medium- (3-10-day) and extended-range (10-30-day) quantitative precipitation forecasts (QPFs) and probabilistic QPFs (PQPFs). Therefore, the goal of this study is to predict the diurnal climatology of precipitation given the forecast of the large-scale circulation conditions, which still retain predictability in the extended range.

In addition, most ensemble prediction systems are characterized by under-dispersion that limits the utility of probabilistic predictors. Here we use Analog Post-processing (AP; Hamill and Whitaker 2000; Hamill et al. 2015) to produce posterior ensembles with reasonable spread to effectively mitigate the problem of under-dispersion. Frequency counting and PM are then separately applied to the AP ensemble to produce calibrated and downscaled PQPFs and bias-reduced QPFs, respectively.

### Data Sources and Validation

- Forecast: SubX EMC-GEFS
  - period: Jan 1999 - Dec 2016 (retrospect, 10 members); Aug 2017 - Sep 2020 (forecast, 20 members)
  - update frequency: once per week, with forecasts initialized at 00 UTC every Wednesday
  - horizontal resolution: 1 x 1° lonlat
- Observation: gridded precipitation analysis based on rain gauge data
  - period: Jan 1999 - Sep 2020
  - horizontal resolution: 1 x 1 km
  - analysis technique: Simple Kriging
- Validation period: Jan 1999 - Sep 2020
  - leave-one-out cross validation

### Statistical post-processing procedure (SPP) for precipitation forecasts

probabilistic 7-day accumulated precipitation forecasts

observed 7-day accumulated precipitation forecasts

Frequency counting

AP-based PQPF

Raw QPF

Raw ensemble forecast is under-dispersive with an obvious wet bias

AP ensemble spread well represents forecast uncertainty

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### Methodology

#### Analog Post-processing (AP)

Latest forecast

Historical forecasts

Historical observations (calibrated ensemble)

step 1 pattern matching

step 2 forecast-to-observation correspondence

Search for 20 best historical forecast analogs

Use the 20 sets of observations, each corresponding to 1 forecast analog, as an AP ensemble

Search area for pattern matching

#### Distance-based Similarity Criterion (D)

$$D(i) = \sqrt{\frac{1}{L} \sum_{l=1}^L (x^{l,c} - x^{l,f})^2 + \frac{1}{L} \sum_{l=1}^L (x^{l,c} - x^{l,o})^2}$$

$x$ : forecast variable (precipitation)  
 $c$ : current date  
 $f$ : chosen date in the archive  
 $L$ : number of grid points for pattern matching  
 $M$ : number of ensemble members

ensemble mean:  $\bar{x} = \frac{1}{M} \sum_{m=1}^M x_m$

ensemble spread:  $\sigma = \sqrt{\frac{1}{M-1} \sum_{m=1}^M (x_m - \bar{x})^2}$

### Evaluation of ensemble distribution

#### Analysis rank histogram

Raw ensemble forecast is under-dispersive with an obvious wet bias

AP ensemble spread well represents forecast uncertainty

#### Frequency distribution of precipitation

AP ensemble is much closer to observation than raw ensemble.

### Evaluation of PQPF (precipitation > 100 mm/wk)

#### Reliability

Raw forecast has obvious over-forecasting, while calibrated one has good reliability

#### Discrimination

Calibrated PQPF has higher skill in discrimination than raw forecast

#### Economic value

users with a much wider spectrum of cost-loss ratio can obtain more benefit from the calibrated forecast as compared to the raw forecast.

### Conclusions

- Ensemble distribution
  - Raw ensemble is under-dispersive with an obvious wet bias, while AP ensemble is calibrated with most of the bias removed.
  - For frequency distribution of precipitation, AP ensemble is much closer to observation than raw ensemble.
- AP-based probabilistic precipitation forecast, compared to raw QPF, has
  - better reliability and higher skill in discrimination
  - higher economic value for a much wider spectrum of cost-loss ratio

### Acknowledgement and references


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# 附錄 4 海報論文發表：Implementation of Probabilistic Impact-based Decision Support Services (IDSS) in the Central Weather Administration (CWA)



## Implementation of Probabilistic Impact-based Decision Support Services (IDSS) in the Central Weather Administration (CWA)

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### Background & Challenges

The increasing frequency and intensity of extreme weather events necessitate the development of more advanced and reliable weather forecasting and early-warning systems. To achieve the goal of becoming a prepared national weather institution, the CWA has adopted the strategy of probabilistic IDSS, as formalized by the National Weather Service (NWS), collaborating with public sectors to aid users in making optimal decisions under forecast uncertainty, aiming to reduce societal, safety, and economic risks under climate change.

The challenges of meteorological data/application across sector:

- insufficient depth in cross-domain application of meteorological data/information
  - enhancement of **translation and customization** for meteorological information
  - development of efficient **communication mechanisms**
- high complexity** in cross-domain collaboration within the agricultural sector
  - lack of a unified communication channel
  - difficultly in developing comprehensive solutions
- policy guidance: **revitalizing industries**

### Implementation: A Case on the Application of 2-meter Temperature Forecasting for Agricultural Crops

**Analysis Data:** Taiwan Station-based Analysis

- data period: 1998-now
- grid spacing: 1 km
- time resolution: daily

**Forecast:** NCEP GFS v12

- grid spacing: 0.5 deg
- time resolution: 6 hourly

**Statistical Post-Processing Technique:**

- bias correction to improve the reliability of forecasts
- Downscaling for the demand of fine spatial scale (e.g. 1km)
- Probabilistic and customized products

Ex. tercile probabilistic forecast, signal-based early-warning.

**Quantification of benefits with EV analysis**

In addition to quantifying the value of forecasts, EV analysis can also provide the probability thresholds that provide the highest economic benefits, significantly aiding users in decision-making.

**An user-friendly tool to transfer probabilistic/decision-making information**

**Stage 1: comprehensive forecasting** including deterministic forecasts (e.g., ensemble mean) and information on forecast uncertainty.

**Stage 2: optimal decision suggestion for the maximum economic benefit** combining probabilistic forecasts and cost-loss information with economic value (E-V) analysis.

### Conclusion & Future work

The CWA has provided decision-based products, including: 1) signal-based early-warnings for specific locations, and 2) optimal decision suggestion. Future work will be directed towards **scenario-based** forecast guidance, applications combining **AI/ML** technology, and the optimization and development of **visual decision support service**, all aimed at enhancing socioeconomic benefits through disaster mitigation and prevention.

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