National Taiwan University
Department of Atmospheric Scieces

Newsletter

2021. 12 NO. 14

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CONTENTS

Honor and Award

- Prof. I-I Lin received the 25th National Chair Professorship in 2021.
- Prof. I-I Lin received the Taiwan Outstanding Women in Science Awards in 2021.
- Prof. Jen-Ping Chen was appointed as a Fellow of the Meteorological Society, Republic of China in 2021.
- Prof. Min-Hui Lo received the Franco-Taiwanese Scientific Grand Prize 2021.
- Prof. Po-Hsiung Lin received the NTU Outstanding Teaching Award of 2020 Academic Year.
- Prof. Wei-Ting Chen received the NTU Distinguished Teaching Award of 2020 Academic Year.
- Prof. Po-Hsiung Lin was promoted to Professor on August 1, 2021.
- Prof. Hui-Ming Hung was promoted to Professor on August 1, 2021.

- 林依依教授榮獲教育部第 25 屆國家講座。
- 林依依教授榮獲第 14 屆臺灣傑出女科學家獎。
- 陳正平教授獲選 2021 年中華民國氣象學會會士。
- 羅敏輝副教授榮獲 2021 年第 23 屆臺法科技獎。
- 林博雄教授獲 109 學年度教學優良獎。
- 陳維婷副教授獲 109 學年度教學傑出獎。
- 林博雄老師自 110 年 8 月起升等教授。
- 洪惠敏老師自 110 年 8 月起升等教授。

Personnel Changes

- Prof. Cheng-Ku Yu assumed as a department Chair since August 1st, 2021.
- Prof. Yu-Chiao Liang joined the department faculty since August 1st, 2021.
- 游政谷老師自 110 年 8 月 1 日起擔任本系系主任。
- 梁禹喬老師自 110 年 8 月 1 日起到系服務。

Prof. Yu-Chiao Liang joined the Department Faculty

我的研究主要關注極區氣候的劇烈變化，以及探討其劇烈變化對極區內天氣氣候系統的影響和透過改變全球大尺度環流對極區外產生的影響。除了使用新一代的全球氣候模式來進行研究外，我也喜歡學習新的分析及數學工具，例如機器學習等方法。我熱衷於跟其他不同領域的科學家合作，一起探討地球系統及全球暖化相關的問題。最後期望自己能替台灣氣候學研究貢獻一點心力。

學歷 Education：

美國加州大學爾灣分校博士 2018

經歷 Experience：

國立台灣大學大氣系	助理教授 2021-now
美國哥倫比亞大學-Lamont Doherty Earth Observatory	博士後研究員 2020-2021
美國烏茲霍爾海洋研究所海洋物理系	博士後研究員 2018-2020

專長 Expertise or Research Interests ：

極區氣候暖化，氣候動力

In Memory of Prof. Kuo-Nan Liou

Professor Kuo-Nan Liou, an outstanding faculty member of our department, passed away in the United States on March 20, 2021. All the teachers and students of the department are deeply moved and express their infinite gratitude and thoughts from the heart.
Professor Liao was elected as the 2013 NTU Distinguished Alumnus of NTU on November 15, 2013.
Link to the video as follows: https://www.youtube.com/watch?v=Tn_AC0ir6-c&t=35s

本系傑出系友廖國男教授於 2021 年 3 月 20 日病逝於美國家中，本系全體師生深感不捨，並衷心表達無限的感激與思念。廖教授於 2013 年 11 月 15 日臺大創校 85 年校慶時，獲遴選為臺大傑出校友之影片連結：https://www.youtube.com/watch?v=Tn_AC0ir6-c&t=35s

Photo Memory

Group photo with Prof. Liou In NTUAS' Commencement Ceremony

Group photo with Prof. Liou

MOU for Building an Earth Science Cooperation Platform between Central Weather Bureau and NTU

Memorandum of Cooperation for building an Earth Science Platform was signed between National Taiwan University and the Central Weather Bureau on March 29, 2021. The Dean of the College of Science Chun-Chieh Wu signed the contract with the Central Weather Bureau on behalf of the NTU. Our department will also have more cooperation with CWB in academic research and practical experience in the future.

國立臺灣大學與中央氣象局於 2021 年 3 月 29 日簽署「建構地球科學合作平臺」合作協議，理學院院長吳俊傑代表本校與中央氣象局簽約，本系亦將在學術研究及實務經驗等面向與氣象局有更多的交流合作。

Group photo of CWB with the Dean of the College of Science and the chair of the Department of Atmosphere Sciences

NTU Azalea Festival

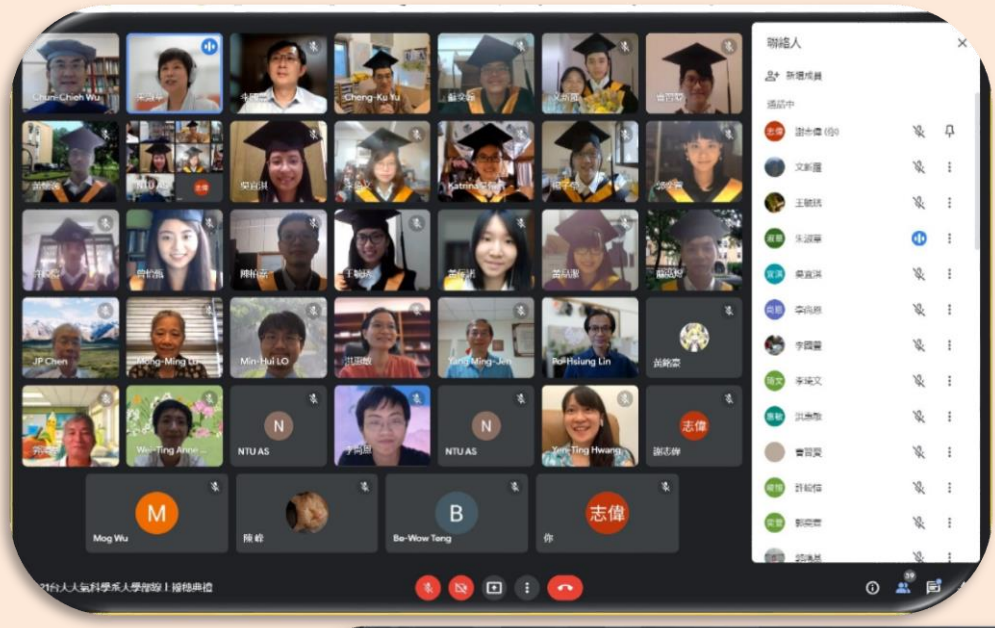
Due to the COVID-19 pandemic's impact on Taiwan, the Azalea Festival was held on line on March 6 and 7, 2021. Our department also cooperated with the school's measures to pre-record the video for the introduction of our department, and our teacher Wei-Ting Chen and the students had an on-line Q&A about our course and experiment on that day to provide a relevant information to students who are interested in the Department of Atmospheric Sciences.

因受新冠肺炎疫情影響，本校於 2021 年 3 月 6 日及 7 日舉辦之杜鵑花節活動，在配合防疫措施下，開幕式及學系博覽會改採線上直播方式。本系亦配合學校措施，提供預錄之系所簡介，並於當天由學生訪問系上陳維婷老師進行線上直播介紹系所課程與 Q&A，提供相關資訊給對大氣科學系有興趣的同學。

Commencement Ceremony

Due to the COVID-19 pandemic's impact, NTU's Commencement Ceremony was held online on the morning of June 26, and the hooding ceremony for the new graduates of NTUAS was held in the afternoon on the same day. We held the ceremony by google meet and projected the live streaming video to YouTube in the same time. At first, the Dean of the college of Science, the department chair, and our teachers took turns to have a speech, then the graduates shared their graduation speech one by one. This is the first time to hold the ceremony online, and our teachers, graduate students and their families experienced a different hooding ceremony and had a joyful and sweet memory in the afternoon. The students graduating from NTUAS in 2021 include 28 Bachelors', 20 Masters', and 2 Doctorate degree holders.

今年臺灣大學畢業典禮因受疫情影響，於 6 月 26 日早上改為線上舉行，系上接著於同日下午舉行了大學部及研究所的線上撥穗典禮，這是本系第一次線上舉行，使用 Google meet 軟體並同時使用分鏡處理於 Youtube 進行直播，首先院長、系主任及學生導師們輪流致詞，接著請畢業班同學每人分享畢業感言，並敬邀家長們也同步觀賞並協助學生撥穗，氣氛溫馨感人，大家體驗了一個不同的畢業典禮。今年系上共有 28 名學士，20 名碩士及 2 名博士畢業。



Parents Day

Every September before the new semester starts, NTU holds a Parents-teacher meeting. Due to the COVID-19 pandemic's impact this year, NTU hold an on-line activity for this topic to help the freshmen know the campus well. Our department Chair, Prof. Cheng-Ku Yu held an on-line meeting for the 1st year students and their parents on September 12, 2021, and introduced the environment and the information of the curriculum to them. This meeting provided the opportunity for them to interact with our faculty and staff and helped them to know the department well.

每年 9 月開學前臺灣大學會舉辦校級新生家長日，今年因應 COVID-19 疫情影響，本屆新生學習入門書院將轉為線上進行。並推出資訊懶人包、Podcast 及線上直播，協助新生快速熟悉臺大生活與環境。本系亦於 9 月 12 日舉行線上新生家長日，由系主任游政谷老師主持，邀請家長們及新生了解大氣系系況、課程及環境，於線上進行交流。

Student Awards

- Tzu-Ying Yang received the MOST College Student Research Creation Award in 2020 academic year and Tzu-Ying's advisor, Prof. Min-Hui Lo, guided her study very well.
  楊子瑩同學獲得科技部 109 年度大專學生研究計畫研究創作獎，其指導教授羅敏輝老師也獲頒指導有方的獎牌。

- Tzu-Han Hsu received the NTU Altruism Award in 2020 academic year.
  徐子涵同學獲得 109 學年利他獎。

- Yi-Shin Jang, Yu-Lai Chang, Pei-Syuan Liao, and He-Ming Xiao received awards of 2021 Atmosphere Sciences Workshop for Graduate of Meteorological Society of the Republic of China.
  張譯心、張玉來、廖珮軒及肖鶴鳴同學獲中華民國氣象學會 2021 年大氣科學研究生研討會特優獎及優等獎。

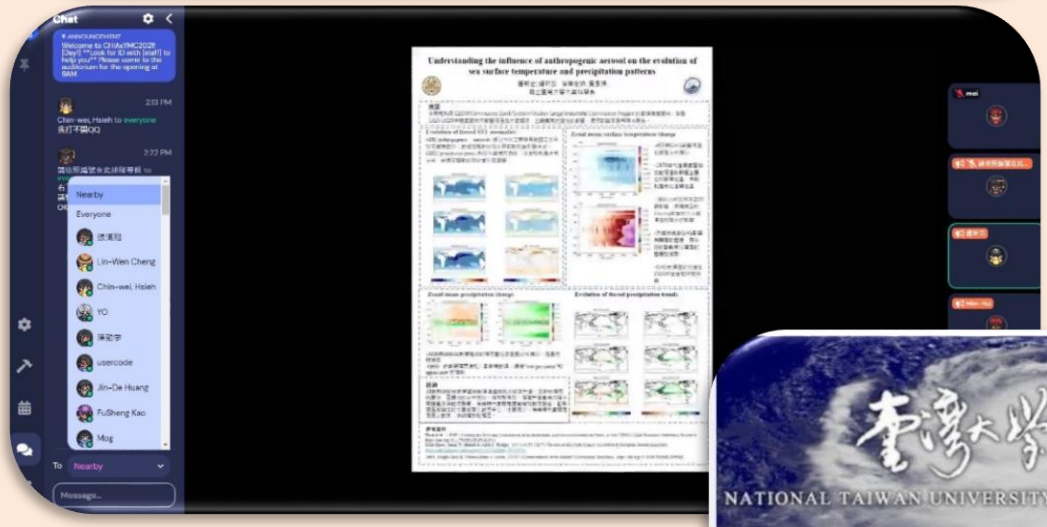
2021大氣科學研究生研討會
得獎名單

	博士班 不分領域	碩士班 氣候分析與模擬	碩士班 大氣物理與化學	碩士班 綜觀中小尺度天氣動力
特優獎	張譯心	蔡雨虔 廖珮軒	張哲維	周子睿 張玉來
優等獎	肖鶴鳴		陳威儒	楊承霈 藍晨豪
佳作獎	李怡茹		陳誼	周彥誠 楊立宇

恭喜以上獲獎同學！

2021 Undergraduate In-house Summer Research-Poster Presentation and Awards

To encourage undergraduate students to participate in research activities, the In-House Summer Research was proceeding during the summer vacation. There were 13 teachers and 23 students including sophomore and junior students for this activity and the name list is as follows. These students shared their results from their research and were awarded for the best 3 poster winners by the research advisers, research assistants, and graduate students.



為促進大學部學生研究能量，本系於暑假期間推行「大專生暑期研究計畫」。本次活動共計 23 位二、三年級學生分別接受 13 位系上教師指導並進行研究，分組名單如下表。今年因受疫情影響，此活動於 9 月 17 日下午改由線上舉辦海報成果發表會，同學們彼此分享研究成果及討論交流，最終由指導教師、研究助理及研究生一同選出前三名得獎者分別為鐘晨瑋、吳宥廷及王逸同學並贈送禮品以茲鼓勵。

場次 Group	編號 No.	指導老師 Name of Teachers	學生姓名 Name of Students
第一組	1	洪惠敏	蔡杰森
第一組	2	洪惠敏	陳峰
第一組	3	陳維婷	張淯翔
第一組	4	陳維婷	陳迦勒
第一組	5	吳健銘	謝晉維
第一組	6	吳健銘	黃子強
第一組	7	羅敏輝	張淳皓
第一組	8	羅敏輝	歐德昱
第一組	9	黃彥婷	鍾昕芸
第一組	10	游政谷	楊心宇
第一組	11	吳俊傑	陶昱丞
第一組	12	吳俊傑	蕭柏智
第二組	13	楊明仁	朱品瑞
第二組	14	楊明仁	林瑞均
第二組	15	林博雄	陳劭宇
第二組	16	林博雄	周子涵
第二組	17	林博雄	鐘晨瑋
第二組	18	陳正平	高富聖
第二組	19	陳正平	范傑翔
第二組	20	郭鴻基	張晉瑜
第二組	21	梁禹喬	吳宥廷
第二組	22	梁禹喬	王 逸
第二組	23	盧孟明	黃聖丰

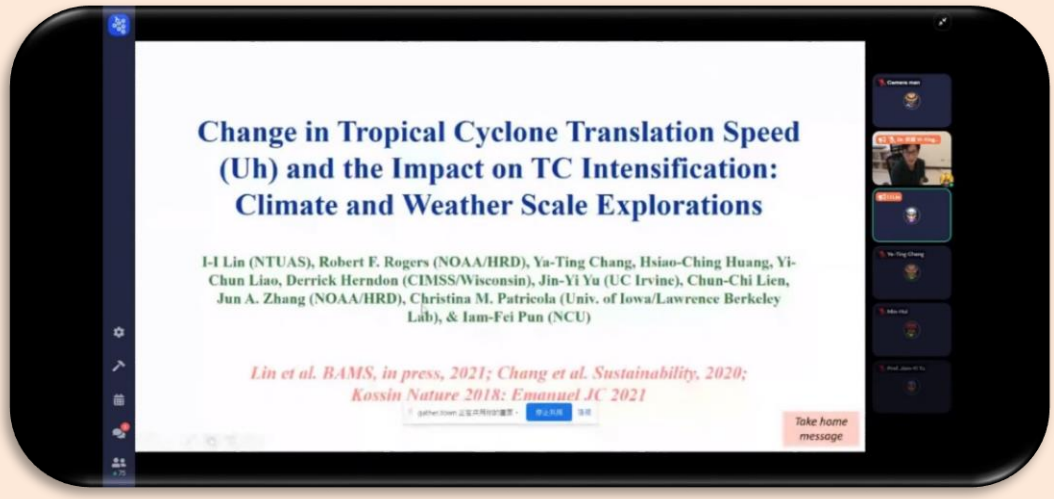
Department Chair Meeting with Students

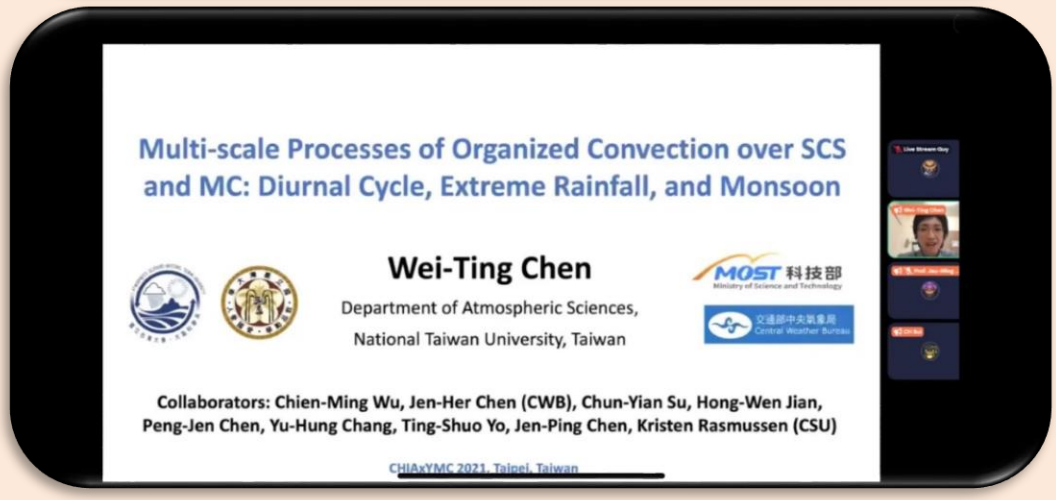
Prof. Yu, the Department Chair held the Chair meeting with students of the first and the second year, the third and the fourth year, and the graduate students on December 7, December 14, and December 21 respectively. In addition to introducing the course requirements to undergraduate students and graduate students and encouraging them to plan their career earlier, the department also awarded the scholarship to the excellent students. The meeting minutes including the students' questions/suggestions and the department's responses were posted on the website of the department.

系主任游政谷老師分別於 12 月 7 日、12 月 14 日及 12 月 21 日中午與大一大二、研究所及大三大四同學舉辦系主任時間，會中除了介紹大學部及研究所課程修課規定及鼓勵同學及早做生涯規劃外，也頒發了 109 年第二學期書卷獎給得獎同學，最後更開放同學現場發表問題及意見，並將問題及回覆處理情形置於本系網站，供師生參考。

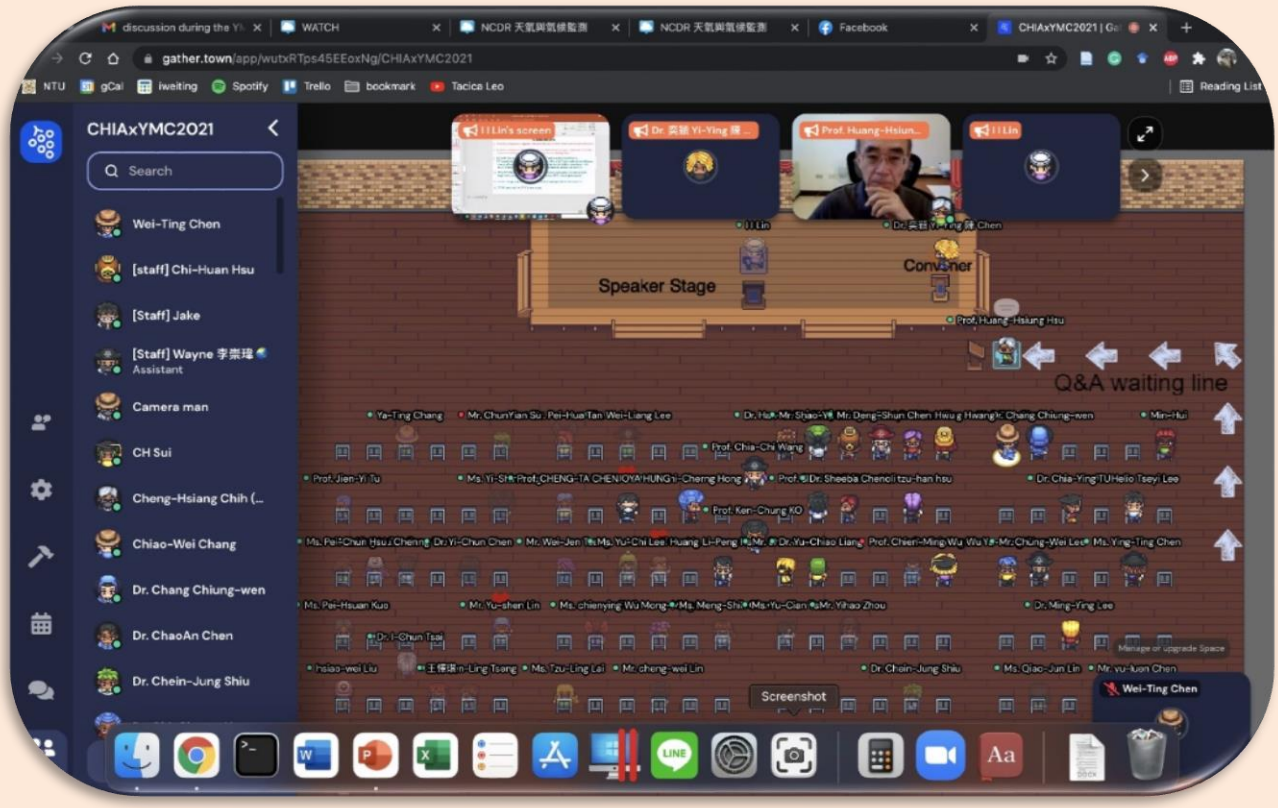
2021 Climate Hotpot in Action Forum and Year of Maritime Continent Workshop

The 2021 Climate Hotpot in Action Forum and Year of Maritime Continent Workshop was jointly organized by our department and the Research Center for Environmental Changes, ACADEMIA SINICA on September 1-3, 2021, and the conference was held in combination with the CHIA Climate Hotpot in Action Forum and Year of Maritime Continent Workshop. Due to the COVID-19 pandemic's impact, the conference was held on line, and its program were including the keynote speeches, poster presentation, and discussions. Approximately 150 people registered for the conference, and 97 people at the highest peak joined the meeting online at the same time. The subject for this conference was about the future climate research and development in Taiwan and Maritime Continent. Some of our department faculty and students joined the meeting and discussed and shared the academic idea with each other. The conference ended successfully with everyone's enthusiastic participation.





本系與中央研究院環境變遷研究中心於 110 年 9 月 1 日至 3 日聯合舉辦 2021 氣候論壇暨 YMC 國際研討會，此會議是結合 CHIA 氣候論壇與第五屆 YMC 國際科學研討會聯合舉行。今年因受疫情影響，研討會全程為線上會議，內容包含遠距演講，壁報展示以及各類的討論互動等。與會國家包括美國、斯里蘭卡、南韓、日本、台灣、印尼、菲律賓、新加坡、印度及中國等多國氣候專家學者參與，會議註冊人數約 150 人，最高峰同時有 97 人在線上聆聽專題演講。此會議主題著重於臺灣及海洋大陸未來氣候研究發展，本系尚有多名老師及學生發表論文及演說。此次會議雖因疫情衝擊改為線上，各國氣候界學者仍踴躍參與此遠距會議，並熱烈的討論及交換彼此意見，成功達到國際間的學術交流，也讓此會議順利圓滿落幕。



CFMIP 2021 Virtual Meeting

The CFMIP 2021 Virtual Meeting was jointly organized by Prof. Yen-Ting Huang of our department, Prof. Florent Brient of Institute Pierre Simon Laplace and Pro. Paulo Ceppi of Imperial College London on September 14-16, 2021. Due to the COVID-19 pandemic's impact, the meeting was held on line and the subject was to continue the spirit of the cloud feedback project and invited the experts in theoretical discussions, climate model development, and data analysis of satellite observation to discuss the effect of the cloud、rainfall、atmospheric circulation and climate sensitivity under the climate change.

本系黃彥婷老師於 2021 年 9 月 14 日至 16 日舉行與法國 IPSL 國家實驗室科學家 Florent Brient、英國倫敦帝國學院教授 Paulo Ceppi，以及韓國蔚山科學技術院(UNIST)教授 Sarah Kang 聯合主持由世界氣候研究計畫(World Climate Research Program, WCRP)支持的氣候模式雲反饋比較計畫(Cloud Feedback Model Intercomparision Project, CFMIP)的年會。因受疫情影響，此研討會全程為線上會議，主題為延續雲反饋比較計畫的精神並邀請理論探討、氣候模式發展，以及衛星觀測資料分析的專家，一同討論氣候變遷下，雲、降雨、環流與氣候敏感度 之反應等子議題。議程如下:

Day 1: Tuesday, September 14, 2021	
05:00 to 05:30 **UTC**	Opening (coffee & help with Gather)
05:30 to 05:45	Welcome (Masahiro Watanabe) Introduction to the conference (Yen-Ting Hwang & Sarah Kang) **Keynote room**
05:45 to 07:30	Poster sessions **Room A & B**: Forcing, Feedbacks and Climate Sensitivity
07:30 to 8:30	Ice breaker (**Lounge room**)
	MID-DAY BREAK
14:00 to 14:30 **UTC**	Opening (coffee & help with Gather)
14:30 to 14:45	Welcome (George Tselioudis) Introduction to the conference (Florent Brient & Paulo Ceppi) **Keynote room**
14:45 to 16:30	Poster sessions **Room A & B**: Forcing, Feedbacks and Climate Sensitivity
16:30 to 17:30	Ice breaker (**Lounge room**)
18:00	*END OF DAY 1 (CHAT ROOM CLOSED)*
Day 2: Wednesday, September 15, 2021	
05:00 to 05:30 **UTC**	Opening (coffee & help with Gather)
05:30 to 07:30	Poster sessions **Room A**: Observations and Model Evaluation **Room B**: Coupling of clouds with Atmospheric and Oceanic Circulation
07:30 to 8:30	Keynote talk: "On climate sensitivity and the use of models in IPCC AR6" Thorsten Mauritsen **Keynote room**
	MID-DAY BREAK
14:30 to 16:30 **UTC**	Poster sessions **Room A**: Observations and Model Evaluation **Room B**: Coupling of clouds with Atmospheric and Oceanic Circulation
16:30 to 17:30	Keynote talk: "On climate sensitivity and the use of models in IPCC AR6" Kyle Armour **Keynote room**
18:00	*END OF DAY 2 (CHAT ROOM CLOSED)*
Day 3: Thursday, September 16, 2021	
05:00 to 05:30 **UTC**	Opening (coffee & help with Gather)
05:30 to 07:30	Poster sessions **Room A:** Precipitation and Hydrological Sensitivity **Room A:** Extratropical Cloud Processes and Feedbacks **Room B**: Convective Processes
07:30 to 8:00	Good bye (**Keynote room**)
	MID-DAY BREAK
14:30 to 16:30 **UTC**	Poster sessions **Room A:** Precipitation and Hydrological Sensitivity **Room A:** Extratropical Cloud Processes and Feedbacks **Room B**: Convective Processes
16:30 to 17:00	Good bye (**Keynote room**)
18:00	*END OF THE CONFERENCE (CHAT ROOM CLOSED)*

VISTOR

- Dr. Yu Cheng of ClimaCell, Senior Atmospheric Data Scientist visited the department on February 4th, 2021, and delivered a seminar titled “Weather Forecast? Weather Intelligence!”.

- Professor Pei-Ling Wang of Institute of Oceanography, National Taiwan University visited the department on March 11th, 2021, and delivered a seminar titled “Biogeochemical Cycle and Climate: The Lithosphere”.

- Professor Pai-Ta Shih of Department of Finance, National Taiwan University visited the department on March 29th, 2021, and delivered a seminar titled “Environment and Finance”.

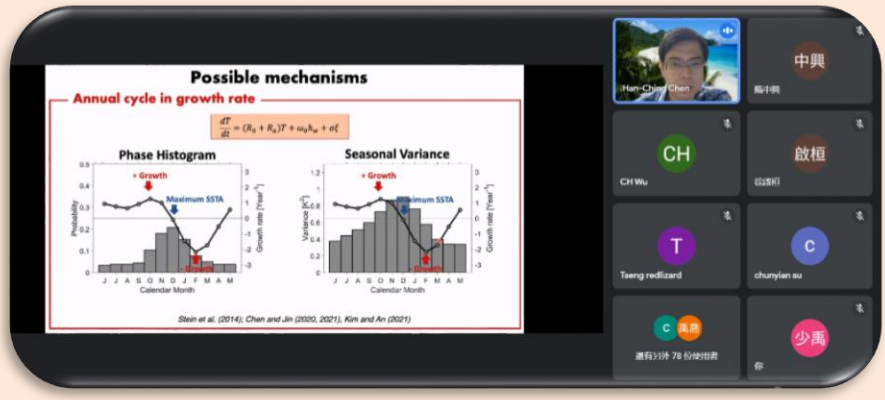
- Dr. Bo-Wen Shen of Associate Professor, Department of Mathematics and Statistics, San Diego State University visited the department on May 18th, 2021, and delivered a seminar titled “An Insightful Analysis of the Lorenz 1969 Model:A Perspective of Chaotic Dynamics”.

- Assistant Researcher Buo-Fu Chen of Center for Weather Climate and Disaster Research, NTU visited the department on February 23th, and delivered a seminar titled “深度學習神經網路與氣象-二十個問答”.

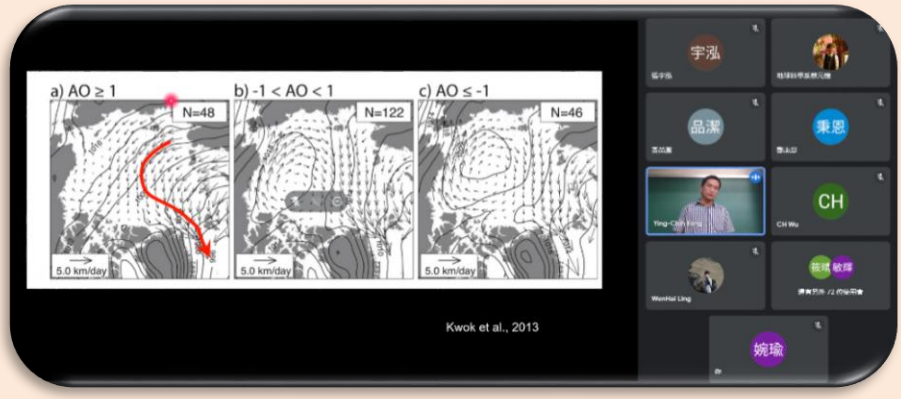
- Professor Jr-Chuan Huang of Department of Geography, National Taiwan University visited the department on March 25th, 2021, and delivered a seminar titled “Biogeochemistry Cycle and Climate: Biogeochemical cycles in Rivers and Estuaries”.

- Dr. Johnny Luo of Department of Earth & Atmospheric Sciences, City University of New York visited the department on May 4th, 2021, and delivered a seminar titled “Satellite-based estimate of convective mass flux: global survey and validation against radar wind profiler observations”.

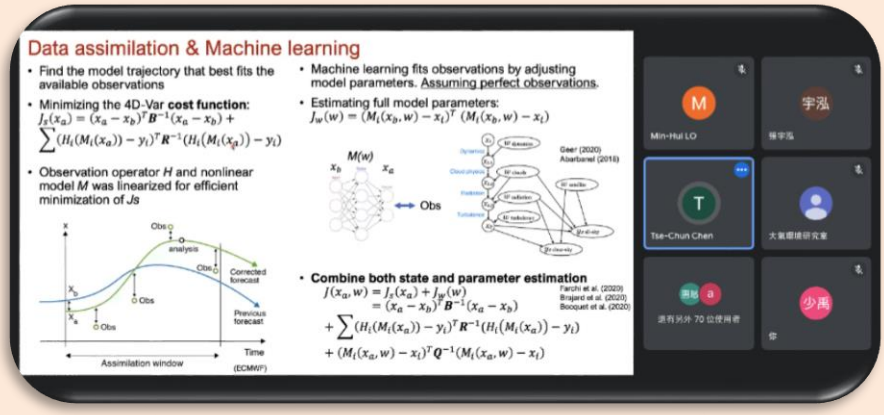
- Dr. Han-Ching Chen of University of Hawaii at Manoa, Hawaii, USA visited the department on September 28th, 2021, and delivered a seminar titled “ENSO Phase-Locking in Recharge Oscillator Framework”.



- Professor Yin-Chih Feng of Department of Oceanography, National Sun Yat-sen University visited the department on October 5th, 2021, and delivered a seminar titled “Early winter upper-ocean variability in the Amundsen Basin, Arctic Ocean, using Lagrangian observations from the MOSAiC expedition”.



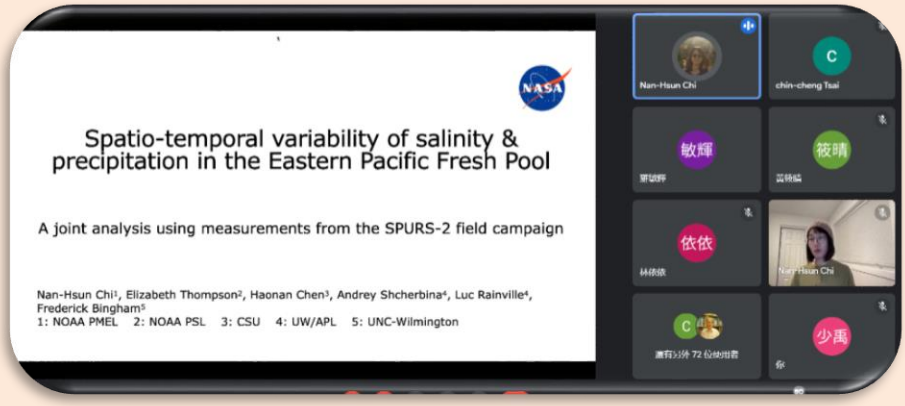
- Dr. Tse-Chun Chen of CIRES of CU Boulder / NOAA Physical Science Laboratory visited the department on October 12th, 2021, and delivered a seminar titled “Combining Machine Learning and Data Assimilation in Numerical Weather Prediction”.



VISTOR

- Prof. John Chiang of University of California - Berkeley visited the department on October 19th, 2021, and delivered a seminar titled “Two distinct annual cycles of the Pacific cold tongue under orbital precession”.

- Dr. Nan-Hsun Chi of NOAA PMEL Ocean climate division visited the department on October 26th, 2021, and delivered a seminar titled “Spatio-temporal variability of salinity in the Eastern Pacific Fresh”.



- Dr. Tsung-Lin Hsieh of High Meadows Environmental Institute, Princeton University visited the department on November 8th, 2021, and delivered a seminar titled “Tropical cyclones in the future: more or less frequent, and why”.

- Dr. Aaron Wang of the Department of Meteorology and Atmospheric Science, Pennsylvania State University visited the department on November 11th, 2021, and delivered a seminar titled “Toward Improving Near-Surface Wind Fields in Large-Eddy Simulations of Tornadoes”.

- Dr. Ho-Hsuan Wei, Postdoctoral researcher of the Department of Atmospheric and Oceanic Sciences, University of Colorado Boulder visited the department on November 16th, 2021, and delivered a seminar titled “Exploring the roles of subsurface ocean structure in El Niño development and subseasonal forecast over the tropical Pacific”.

- Dr. Chia-Wei Hsu, Postdoctoral Fellow of Colorado State University visited the department on November 23th, 2021, and delivered a seminar titled “Ocean Surface Flux Algorithm Effects on Tropical Indo-Pacific Intraseasonal Precipitation ”.

VISTOR

- Prof. Ming-Huei Chang of the Institute of Oceanography, National Taiwan University visited the department on December 14th, 2021, and delivered a seminar titled “Simultaneous oceanic and atmospheric observations along the Kuroshio east of Taiwan: Field work and preliminary results”.
- Dr. Chia-Chun Hsu of Taiwan Forestry Research Institute visited the department on December 14th, 2021, and delivered a seminar titled “棲蘭的樹冠層微氣候觀察–「撞到月亮的樹」台灣杉等身照拍攝棲蘭台灣杉三姐妹–女性爬樹科學家的探索故事”.

- Dr. Heng-Wang of University of California, Davis visited the department on December 16, 2021, and delivered a seminar titled “Atmospheric rivers: Integrated vapor kinetic energy and preliminary budget analyses”.

- Dr. Chuan-Chieh Chang of Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign visited the department on December 21, 2021, and delivered a seminar titled “Summertime Stationary Waves: Variability, Projected Changes and Implications for Tropical Cyclone Activity”.

The Structure of Organized Convection Systems and Extreme Rainfall over the Asian-Australian Monsoon Region Observed by Satellite Remote Sensing

衛星觀測熱帶與季風區組織性對流系統的結構與極端降水

Wei-Ting Chen / 陳維婷

The Atmospheric Environment Lab in NTUAS, hosted by Prof. Wei-Ting Chen, has been applying the satellite observations to investigate the organized convection systems and extreme rainfall over the Asian-Australian Monsoon (AAM) region. During the seasonal transition from spring to summer, the planetary-scale circulation of the AAM transports massive amount of water vapor from the tropics to the mid-latitudes, accompanied by the occurrence of meso-scale convection systems (MCSs), particularly over the windward coastlines. Climatologically these organized convection systems contributes to more than half of the total rainfall in this region. They are also the major contributor to extreme precipitation events, and the flash floods and lightning activities associated with these organized convective systems have caused severe loss of lives and properties over the densely populated coastal regions. The operational early warning and the future projection of the occurrence of the intense MCSs over the AAM regions in a changing climate will critically rely on improving our knowledge of their spatial-temporal variability as well as the associated environmental conditions.

In the research paper published in GRL in 2021 (Chen et al., 2021), the 0.11 million convective systems identified from the multi-year CloudSat satellite observations over the AAM region were classified objectively by the data-driven machine learning approach. The Cloud Profiling Radar at 94-GHz onboard CloudSat detects vertical profiles of cloud in the atmosphere (Fig.1a). Five distinct convective cloud regimes were classified by the hierarchical agglomerative clustering algorithm, based on the convective systems' physical properties (Fig.1b). As shown in Fig.2, the unique Coastal Intense (CI) regime, mainly occurring over the coastal area, exhibits the most expansive horizontal scales (> 1000 km), multiple convective cores, high convective strength, the strongest cloud radiative effects, the highest probability of extreme rainfall among all regimes, and tightly follows the sharp seasonal switch of the monsoon circulation. The Coastal regime illustrates smaller (but still in O(600 km)) organized coastal convections with the strongest convective strength. Three of the less organized regimes represent convection at various life stages over the land areas. Although the two highly organized coastal regimes only account for 10% of the total convective cloud systems in the AAM region, they pose higher risk to the coastal metropolitans as they are more likely to occur over the coastal areas and associated with higher probability of heavy rainfall. Also, they may not be readily monitored by the current warning/watch systems as less than 10% of the CI and Coastal regimes overlap with the tropical cyclones.

Long-term satellite observations of cloud and precipitation have facilitated the detailed understandings of the structures and distribution of the tropical and monsoonal convection systems. Previous studies have subjectively applied a combination of morphological features to identify and classify the MCSs.

Recent studies have also started to use objective classification/clustering algorithms to distinguish cloud/weather regimes based on the statistical distribution of satellite-observables. Due to the massive data volume, they would apply statistical analysis to the raw data over specific domain/grid areas to represent weather conditions or cloud composition (e.g., joint histograms of cloud optical depth, cloud top height, or radar reflectivity), and then conducted classification based on the statistical parameters. However, it can be difficult to project the classified results back to the physical feature or morphology of the convective clouds. In Chen et al. (2021), the data volume was reduced by connecting the CloudSat vertical profiles into "cloud objects"(Fig.1a), and the classification was based on the classic morphological properties in the literature, but the data-driven approach relieves the need to pre-define thresholds to subjectively select systems of a certain scales or convective intensity. The results reveal that the MCSs in the AAM region can be further separated into sub-categories with horizontal scales between 500-1000 km and those above 1000 km, with distinct separation in their rainfall intensity spectra and outgoing longwave radiation (Fig.2), indicating that they can significantly modulate the seasonal energy budget. The results of this study provide new perspectives to understand the high impact weather and multi-scale interactions of convection over the AAM region in the future.

Reference

Chen, P.-J., W.-T. Chen*, C.-M. Wu, T.-S. Yo (2021), Convective cloud regimes from the classification of object-based CloudSat observations over Asian-Australian monsoon areas, Geophys. Res. Lett., 48(10), doi:/10.1029/2021GL092733

本研究團隊近年來使用衛星觀測資料研究亞洲-澳洲季風區的組織性對流系統與強降雨現象，每年春夏之際季節轉換時，亞澳夏季季風行星尺度的環流輸送大量的水氣且伴隨著組織性對流系統的發生，尤其集中在迎風側的沿岸海面。這些組織性對流氣候上貢獻了熱帶地區一半的降水量，也是極端降水天氣事件的主要原因，造成沿岸都市因洪水或是雷擊產生重大經濟或生命損失。深入研究季風區域沿岸大型組織性對流，對於極端天氣的預警、探討降水與環流的季節變化、以及氣候變遷下季風區降水的變化趨勢都極具重要性。

在今年發表的最新研究成果中(Chen et al., 2021)，我們使用了機器學習的聚合式階層分群法(hierarchical agglomerative clustering)，將 CloudSat 衛星在亞澳季風區觀測到的十一萬朵深對流雲系統進行客觀分類。CloudSat 衛星上搭載的 94-GHz 雲雷達可以探測雲系內部的垂直結構(圖一(a))，群落分析將對流系統分成為五種類型(圖一(b))，其中最高度組織性的兩類對流系統，主要出現在熱帶與夏季季風區的沿岸海面，它們也是發生極端降雨機率最高(圖二)、對輻射能量收支影響最明顯、與夏季季風環流變化最息息相關的類別：超大型的 Coastal Intense 類型，水平延展可達上千公里，內部有多個對流核心與廣闊的層狀雲砧；至於 Coastal 類型的水平範圍也有五、六百公里，且有又強又深的對流核心。此兩類大型對流約占觀測對流系統總數的十分之一，但因為好發於沿岸區域又伴隨較高機率有強降雨，對於沿海都市聚落有較高的潛在風險，而且其中又只有約一成是颱風或熱帶低壓，容易在預警時被輕忽。其餘三型對流系統尺寸較小，並且多發生於陸地上，強降雨的發生率也較低，可能代表了陸地對流系統在生命週期不同階段的狀態。

過去以衛星資料研究熱帶深對流的研究眾多，前人多是根據長期觀察的經驗設定主觀的水平尺寸、垂直高度或內部強度等特徵門檻來挑選研究的特定類型目標。近年也有研究利用機器學習方法對衛星觀測到的雲雨資料進行客觀分類，但為了因應龐大的資料量，通常會先將原始數據先做統計處理，再將個別區域的統計結果進行分類，然而分類後的類型僅能對應到統計特性，很難再回推個別對流系統的原始外型或物理特徵。本研究在方法上的突破，是將 CloudSat 觀測的對流雲都連成系統，藉此得出對流系統的五大關鍵特徵(圖一(a))，而不直接處理構成每個系統的千百筆雷達回波剖面，以此五種特徵進行分群可大幅減少資料輸入量，而分類結果也可直觀對應回原本的雲系外型。過去主觀認定水平三百公里以上即屬組織性對流，本研究發現在此之上可進一步區分出五百、一千公里的類型，在沒有作為分類依據的降雨強度、長波輻射等統計結果中這些類型也都有清楚的區分(圖二)，顯示它們對於極端降雨與氣候能量收支有獨特的貢獻，對於未來了解亞澳季風區的劇烈天氣與對流跨尺度交互作用等議題提供了新的研究面向。

參考文獻

Chen, P.-J., W.-T. Chen*, C.-M. Wu, T.-S. Yo (2021), Convective cloud regimes from the classification of object-based CloudSat observations over Asian-Australian monsoon areas, Geophys. Res. Lett., 48(10), doi:/10.1029/2021GL092733

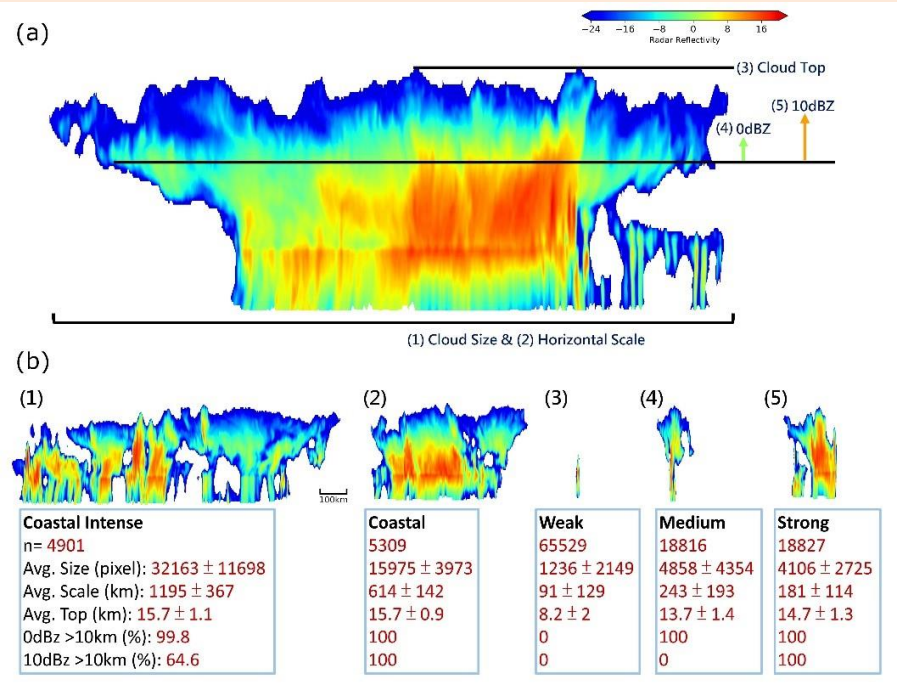


Figure 1: (a) Example of a convective cloud object identified from CloudSat. Colored shading is the radar reflectivity (dBZ). The five key physical properties used in the cluster analysis include: (1) the size (cross-section area), (2) horizontal scale, (3) cloud top height, and (4) 0 dBZ and (5) 10 dBZ reflectivity occurred above 10 km altitude or not. (b) Examples (top row; color shading is radar reflectivity) and statistics of the key features (bottom row) of the five regimes identified by the cluster analysis (n=total number objects in each regime).

圖一:(a)CloudSat 衛星觀測到的對流系統垂直剖面範例，色彩等值線為雷達回波強度(dBz)，標記(1)~(5)為群落分析所使用的對流系統外型或物理特徵：對流系統截面積、水平尺度、雲頂高度、0dBz 與 10 dBz 回波是否超過十公里高度。(b)五型對流系統的例子(上排)與其特徵的統計結果(下排)，n 為該型對流系統觀測到的總數。

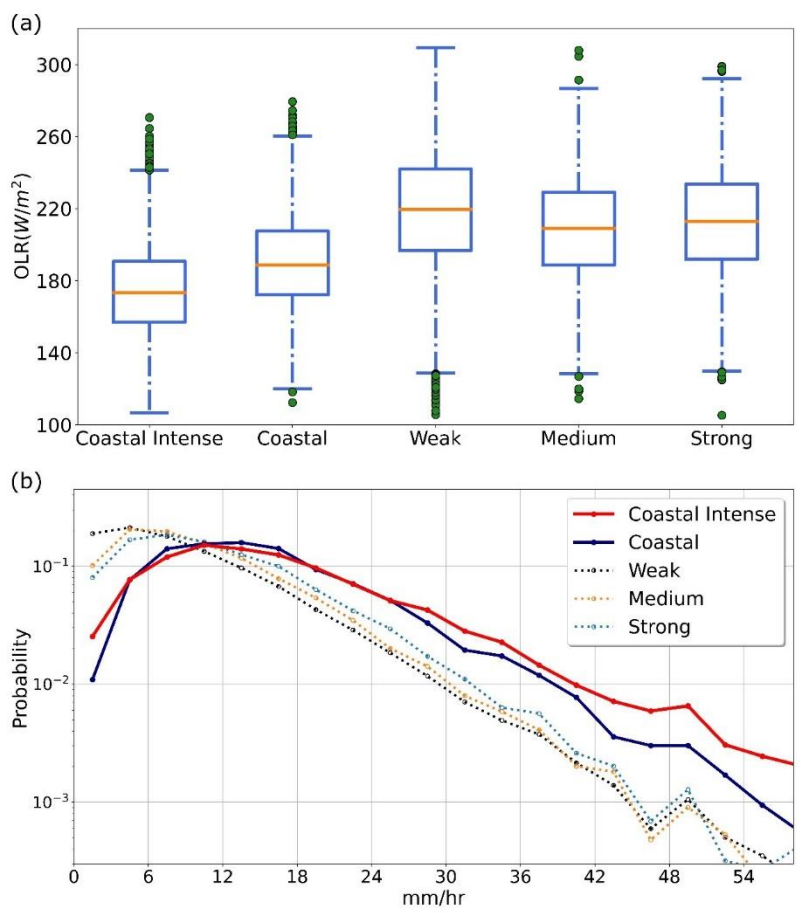


Figure 2: (a) Box plot of areal averaged outgoing longwave radiation and (b) probability distribution of the maximum precipitation within the 6ox6o area surrounding the centroid of each object for the five regimes.

圖二:五型對流系統發生時，在周圍經緯度 6ox6o 範圍內的(a)區域平均大氣層頂向外長波輻射通量統計分布與(b)最大降水強度機率分布。

Arctic Amplification, and its Seasonal Migration, Over a Wide Range of Abrupt CO_2 Forcing

不同二氧化碳濃度作用下北極暖化加強及其季節性變化

Yu-Chiao Liang (梁禹喬); Lorenzo M. Polvani; Ivan Mitevski

The Arctic amplification - specifically referring to the outpace of the near-surface air temperature increases within the Arctic relative to the weaker global temperature increases – is one of the most prominent features as a consequence of the anthropogenic global warming in observations and climate model simulations (Figures 1a and b). However, larger model-to-model difference (Figure 1c) indicates that more studies are needed to improve our understanding of the drivers. This international cooperation research led by the Department of Atmospheric Sciences, College of Science, National Taiwan University, examines the Arctic amplification and its seasonality response to varying CO2 forcing in a suite of climate model experiments. International cooperators include scientists from Columbia University in the City of New York. This study has been accepted in *npj Climate and Atmospheric Science* under Nature Publisher in December, 2021. The online version will be available in early January, 2022.

The causes and effects of Arctic amplification have been extensively attracted climate scientists' interest in understanding the underlying mechanisms. This study uses well-designed global climate model experiments to show that the increasing CO2 concentrations give rise to stronger Arctic warming but weaker Arctic amplification, due to relatively weaker warming of the Arctic in comparison with the rest of the globe due to weaker sea-ice loss and atmosphere-ocean heat fluxes at higher CO2 levels. Researchers further find that the seasonal peaks in Arctic warming and Arctic amplification shift gradually from November to January as CO2 increases (Figure 2). The results suggest that the changes in the magnitude and seasonality of Arctic amplification may have important ecological and socio-economic implications.

北極暖化加強是指北極近地表溫度增加比全世界近地表溫度上升強兩至五倍的現象，此現象是全球氣候暖化下最顯著的氣候表徵之一。本研究利用全球模式實驗加入不同二氧化碳濃度來探討北極暖化加強現象以及其季節性的變化，我們發現北極暖化加強的幅度隨著二氧化碳濃度的增加而減少，同時一年當中北極暖化加強的最大值會逐漸從晚秋(November)移到晚冬(January)，這樣的改變和北極的海冰融化程度和海洋大氣間的熱量傳送有著密不可分的關係。由於北極暖化加強的現象對全球氣候以及經濟可能會產生顯著的影響，因此本研究的結果可以提供生態系及社會經濟層面對應此劇烈變化的參考依據。

References
Yu-Chiao Liang, Lorenzo M. Polvani, and Ivan Mitevski (2022) Arctic amplification, and its seasonal migration, over a wide range of abrupt CO2 forcing. npj Climate and Atmospheric Science (accepted).
Hansen, J., R. Ruedy, M. Sato, and K. Lo (2010) Global surface temperature change. Review Geophysics, 48, RG4004.
Lenssen, N., G. Schmidt, J. Hansen, M. Menne, A. Persin, R. Ruedy, and D. Zyss (2019) Improvements in the GISTEMP uncertainty model. Journal of Geophysical Research Atmosphere, 124, 6307-6326.

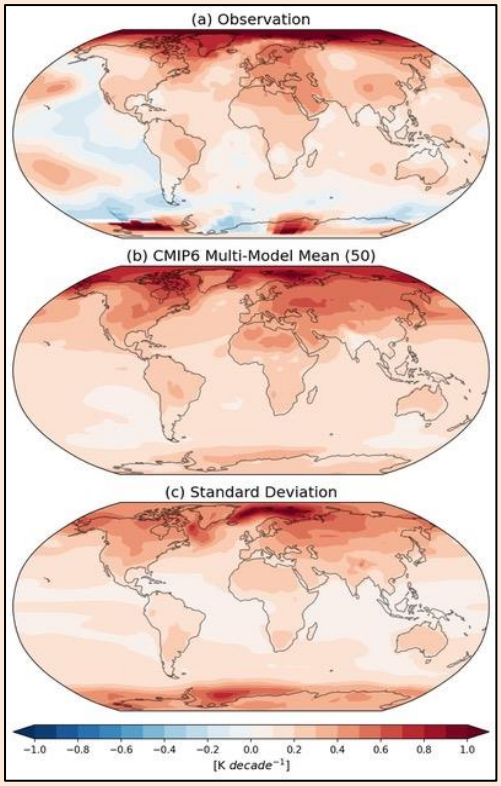


Figure 1. (a) Linear trend map of global near-surface air temperatures during 1979-2014 period based on the observational estimate from NASA Surface Temperature Analysis version 4 (GISTEMP v4) [Hansen et al. 2010; Lenssen et al. 2019, https://data.giss.nasa.gov/gistemp/]. (b) Multi-model mean trend map of global near-surface air temperatures during 1979-2014 period from 50 CMIP6 models. (c) Standard deviation map of the global near-surface air temperature trends across 50 CMIP6 models. Figure courtesy of Mr. You-Ting Wu at National Taiwan University.

圖一。(a) 1979-2014 近地表溫度線性趨勢地圖。(b) 50 組 CMIP6 氣侯模式模擬的近地表溫度線性趨勢圖。(c) 50 組 CMIP6 氣候模式模擬之進地表溫度線性趨勢圖的標準差。感謝台大吳宥廷同學幫忙繪製圖一。

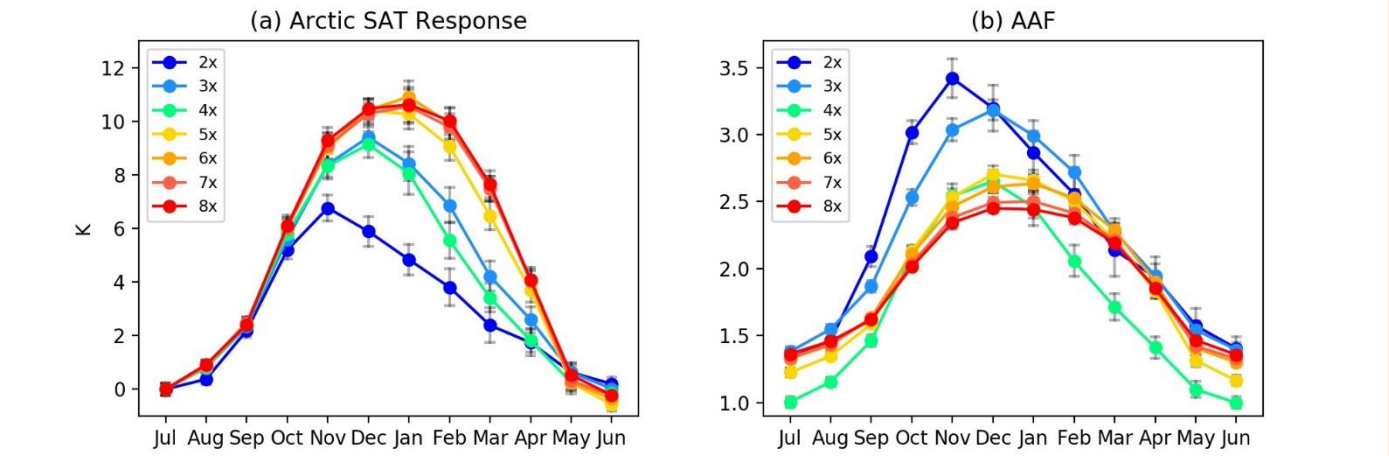


Figure 2. Seasonal evolutions of the Arctic surface air temperature (SAT) response, and AAFs in the CO2 forcing experiments. (a) The evolution of Arctic SAT responses for 2x to 8xCO2. (b) Similar as a but for Arctic amplification factor, defined as the Arctic SAT change divided by global SAT change. Values in (a) are referenced to July values.

圖二。(a) 每個月份近地表溫度隨著不同強度二氧化碳濃度的變化。(b) 同圖(a)，但表示北極暖化加強因子隨著不同二氧化碳濃度的變化。

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  西北太平洋雲街氣膠間接效應之模擬研究
- Chieh-Jen Cheng 鄭傑仁
  The Role of WISHE in the Rapid Intensification of Tropical Cyclones
  WISHE 機制在颱風快速增強的角色

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  台北盆地午後雷雨之理想實驗模擬:西南背景風之角色
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  A Statistical Study of Outer Tropical Cyclone Rainband Formation
  颱風外圍雨帶生成之觀測統計分析
- Yu-Lai Chang 張玉來
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	胡永新	邊界層層積雲對臺灣中部地表氣膠濃度的影響
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