

*Department of Atmospheric Sciences
National Taiwan University*

Newsletter

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Editor: Cheng-Ku Yu (游政谷教授)

Associate Editor: Stephen M. Griffith (谷邁世專案助理教授)

Editorial Assistant: Shih-Ping Chang (張詩蘋)

Department of Atmospheric Sciences, National Taiwan University

No. 1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan

TEL: +886-2-33663927

<https://www.as.ntu.edu.tw/>



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EVENTS

Honors and Awards

- Chair Professor Chun-Chieh Wu received the 29th MOE National Chair Professorship.
- Prof. Hung-Chi Kuo has been reappointed as a Chair Professor of NTU since 2025.
- Prof. Yen-Ting Hwang received the 18th Taiwan Outstanding Women in Science Award - Emerging Talent Award in 2025.
- Prof. Cheng-Ku Yu was elected as a Fellow of the Meteorological Society, Republic of China in 2025.
- Prof. Yen-Ting Hwang received the Eminence Scholar of the College of Science in 2025.
- Prof. Chien-Ming Wu received the NTU Outstanding Teaching Award for the 2024 Academic Year.
- Prof. Kai-Chih Tseng received the NTU Outstanding Teaching Award for the 2024 Academic Year.
- 吳俊傑教授榮獲第 29 屆教育部國家講座。
- 郭鴻基教授續聘國立臺灣大學講座教授(自 114 年起)。
- 黃彥婷教授榮獲 2025 年第十八屆台灣傑出女科學家「新秀獎」。
- 游政谷教授獲選 2025 年中華民國氣象學會會士。
- 黃彥婷老師榮獲 114 學年理學院拔萃學者。
- 吳健銘教授獲 113 學年度教學優良獎。
- 曾開治助理教授獲 113 學年度教學優良獎。

Personnel Changes

- Prof. Yen-Ting Hwang was promoted to Professor on August 1, 2025.
- Prof. Yu-Chiao Liang was promoted to Associate Professor on August 1, 2025.
- Prof. Chiung-Yin Chang joined the department faculty since August 1, 2025.
- 黃彥婷副教授自 114 年 8 月起升等教授。
- 梁禹喬助理教授自 114 年 8 月起升等副教授。
- 張瓊尹老師自 114 年 8 月 1 日起到系服務。

70th Anniversary Celebration of the Department of Atmospheric Sciences

The Department of Atmospheric Sciences celebrated its 70th anniversary on May 10, 2025, with a series of events held at the department building, the International Conference Hall of the College of Management, and La Marée. The celebration began with alumni returning to the department to reconnect with faculty and revisit the department's history through the "Time Corridor" photo exhibition, followed by a symbolic tree-planting ceremony. The event symbolized faculty, students, and alumni of the Department of Atmospheric Sciences working hand in hand to build the future together and build collective solidarity. Following this, the opening ceremony of the anniversary celebration was held at the International Conference Hall of the college of Management and began with opening remarks by the Department Chair Cheng-Ku Yu, followed by speeches from the Vice President of National Taiwan University Shih-Tung Ting and Dean Chun-Chieh Wu. Then the "Alumni Sharing Lecture" was held, featuring two main themes: "Kaleidoscope of Life" and "Academic Life." Several outstanding alumni took turns to share their life and academic journeys and created a warm and lively atmosphere.

In the evening, faculty members, students, and alumni gathered at the restaurant La Marée for a banquet. During the banquet, faculty members and students took turns performing songs and instrumental pieces, showcasing their diverse talents and adding joy and heartfelt moments to the celebration. This event concluded successfully, as faculty, students, and alumni shared an unforgettable and wonderful time together, creating cherished memories for the 70th anniversary celebration of the Department of Atmospheric Sciences.



Photo of alumni taken during the tree-planting ceremony in front of the department building.

EVENTS

本系於 2025 年 5 月 10 日假本系系館、管理學院國際會議廳及水源會館，盛大舉辦七十週年系慶系列活動。活動開始，系友們齊聚系館，與師長們親切交流、合影留念，並漫步於「時光走廊」，欣賞歷年系上重要活動的珍貴影像，重溫共同的青春記憶。隨後，眾人移步至系館前廣場，舉行揭幕植樹典禮。緊接著，系慶開幕典禮於管理學院國際會議廳隆重登場，由游政谷系主任開場引言，接著由丁詩同副校長及理學院吳俊傑院長致詞。隨後舉行「系友分享講座」，分為〈人生萬花筒〉與〈學術人生〉兩大主題，多位傑出系友相繼登台分享人生與學術歷程，現場氣氛熱烈而溫馨。晚間，師生與系友齊聚水源會館共進餐敘。餐會中，師生們輪番上台表演歌唱與樂器演奏，展現多才多藝，為這場盛會增添無限歡樂與感動。整日活動圓滿順利，師生與系友共度了一段難忘而美好的時光，為大氣科學系七十週年系慶留下珍貴回憶。



Group Photo taken during 70th Anniversary Celebration



Photo of the Department Chair Cheng-Ku Yu giving the opening remarks at the 70th Anniversary Celebration



Photo of the Distinguished Alumni Tang-Shan Chen during his Alumni Sharing speech at the 70th Anniversary Celebration

EVENTS



Photo of the Distinguished Alumni Ching-Yen Tsai during his Alumni Sharing speech at the 70th Anniversary Celebration



Photo of the Distinguished Alumni Chih-Pei Chang during his Alumni Sharing speech at the 70th Anniversary



Photo of the Distinguished Alumni, Academician Pao-Kuan Wang during his Alumni Sharing speech at the 70th Anniversary Celebration



Photo of the Distinguished Alumni Huang-Hsiung Hsu during his Alumni Sharing speech at the 70th Anniversary



Group photo of student performers at the banquet of the 70th Anniversary Celebration

Department Retreat

The Department Retreat was held at NTU New Moon Pavilion Cafe on August 8th, 2024, and all the faculty joined together to discuss and share opinions about the Department's future development, including teaching (course optimization), research collaboration, faculty appointments, and talent cultivation.

本系於今年 8 月 8 日假台大新月臺咖啡舉辦教師靜修會，針對系未來的發展包含教學(優化課程)、研究合作、教師聘任及人才培育等方面進行深入討論並交換彼此意見。



Group Photo of Faculty taken during the department retreat

NTU Azalea Festival

In 2025, our school held the Azalea Festival on March 15th and 16th. On the first day, the opening ceremony took place in front of the NTU Sports Center. There were department fairs inside the hall which provided comprehensive information on admissions, scholarships, and detailed introductions to various departments and degree programs, and many booths for the Student Club Expo around the campus. Our department also set up an exhibition booth, offering brief explanations about the department and hosting small activities for students interested in atmospheric sciences as a reference for their further studies.

本校於今年3月15-16日舉辦杜鵑花節活動，首先於綜合體育館前舉行開幕典禮，並在綜合體育館內舉行學系博覽會，提供完整的招生資訊及各學系及學位學程的詳細介紹，校園內亦有學生社團博覽會攤位供學生參觀了解。本系亦於館內設置展覽攤位，提供系所簡介說明以及舉辦小活動供對大氣系有興趣的同學作為升學之參考。



Photo of the Exhibition
Booth of our department
taken during the NTU Azalea
Festival

NTUAS Week

Student Association of NTUAS organized the NTUAS Week November 17 to 21 at Xiaofu Plaza on campus. They sold snacks, promotional materials, and weather bottles at the booth. This photo shows the department chair with students who participated in the event.

本系系學會今年11月17-21日於本校小福廣場舉辦大氣週活動並於攤位販賣小點心、文宣品及天氣瓶。圖為游政谷系主任與參與活動的學生合照。



STUDENTS ACTIVITIES

Commencement Ceremony

The NTU Commencement Ceremony was held on the morning of May 24th for the academic year 113. Following the university ceremony, the undergraduate and graduate ceremonies of our department were held concurrently. Parents were arranged in the same classroom to join the ceremonies together. The ceremony began with speeches by Department Chair Yu, followed by speeches from Dean Wu Chun-Chieh and student advisors, and then a video of a speech given by the teachers of our department to the graduates was played during the ceremony. Next, a representative of the graduating class delivered a graduation speech. The Department Chair turned the tassel from the right to the left for each graduate and gave graduation gifts to them. Everyone was very happy and cherished the opportunity to participate in this graduation ceremony. This year, the department had a total of 33 bachelor's degree graduates, 12 master's degree graduates, and 7 doctoral graduates.



Group Photo taken outdoors during the ceremony (undergraduate students and faculty)



Group Photo taken outdoors during the ceremony (graduate students and faculty)

本校於今年 5 月 24 日舉行 113 學年畢業典禮，本系亦於同日下午於系館實體舉行撥穗典禮，此次採大學部與研究所分開舉行，並邀請家長們一同在教室觀禮。典禮首先由游政谷系主任開場致詞接著由吳俊傑院長及學生導師們輪流致詞，並於現場撥放系上老師們預先提供給畢業生的一段話的影片，氣氛溫馨感人。接著請畢業班同學代表分享畢業感言，再由系主任為每個畢業生撥穗並提供畢業小禮物給每一位畢業生。今年系上共有 33 名學士，12 名碩士及 7 名博士畢業。



Group Photo taken during the ceremony (undergraduate students and faculty)



Group Photo taken during the ceremony (graduate students and faculty)

STUDENTS ACTIVITIES

2025 Undergraduate Summer Research Program Poster Presentation and Awards

To encourage undergraduate students to participate in research activities, the Summer Research Program was implemented during the summer vacation. This activity included a total of 20 students who were guided by 11 teachers to conduct research. Additionally, on the afternoon of August 29th, a Summer Research Program Poster Presentation and Awards was held at Shih-Liang International Conference Hall, NTU. Undergraduate and graduate students were actively participating in discussions. We really thank many faculty members from our department for their guidance, and everyone in engaging in enthusiastic exchanges and learning. These students shared their results from their research and the best 8 poster winners were awarded, as judged by their research advisors, research assistants, and graduate students.



Group Photo taken in front of Shih-Liang International Conference Hall during the Poster Presentation



Group Photo taken at Shih-Liang International Conference Hall during the Poster Presentation

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 20 位二、三年級學生分別接受 11 位系上教師指導並進行研究。另本系於 8 月 29 日下午假理學院思亮館國際會議廳舉行研究計畫成果發表暨海報競賽活動，大學部學生與研究生非常踴躍參與討論，感謝系上多位老師蒞臨指導，大家交流學習熱烈。

恭喜參與本屆暑期計畫的學生如期完成研究工作並分享有趣成果，也恭喜本次活動獲獎學生如下：學術獎(特優):呂晨安，學術獎(優等): 賴昀佳、顏子傑、劉欣，人氣獎: 伍珮慈、蘇心吾、陳宥勳，創意獎: 伍人禾。



Group Photo for the Winners, Prof. Cheng-Ku Yu, Department Chair, Prof. Chien-Ming Wu, Prof. Yen-Ting Hwang, and Prof. Wei-Ting Chen.

STUDENTS ACTIVITIES

Parents Day

Every September before the new semester starts, NTU holds a series of Opening Ceremony activities to help new students to understand the unique characteristics of the university. Our Department Chair, Prof. Cheng-Ku Yu, also held a meeting for the freshman and their parents in the morning of August 31st, 2025, and introduced the environment and the information of the curriculum to them. The Mentor of our department, Prof. Hui-Ming Hung, also explained the counseling procedures of Student Counseling Center, NTU. 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月開學前學校會舉辦新生入門書院活動及開學典禮，幫助學生了解台大校園並迅速適應大學生活。本系亦於8月31日早上於系館舉行新生家長日，由系主任游政谷老師主持介紹大氣系系況、課程及環境讓家長們及新生充分了解本系以及本系關懷導師洪惠敏老師解說學校心輔中心輔導流程，現場互動熱烈，增進新生及家長們與系上的交流。



Group Photo of Freshman, Prof. Cheng-Ku Yu, Department Chair and Prof. Hui-Ming Hung taken during the freshman seminar

Meeting with the Department Chair

Prof. Cheng-Ku Yu held a Chair-Time with students of the graduate students and undergraduate students on November 10th. During the meeting, he introduced the course enrollment regulations for both the undergraduate and graduate programs. He also specially invited Ms. Yen Tzu-Hsiu from the Student Counseling Center to share the center's services and functions, and informed students that they are welcome to proactively contact the center if they need assistance. In addition, Prof. Yu also awarded the Academic Excellence Awards and the NTU Altruism Awards to students. The meeting minutes including the students' questions/suggestions and the department's responses were emailed to faculty and students.

系主任游政谷老師於 11 月 10 日中午舉辦了與研究所及大學部同學的系主任時間，會中除了介紹大學部及研究所課程修課規定外並特別邀請了學輔中心顏慈秀學輔專員分享中心的服務及功能，並告知同學若有需要可以主動聯繫該中心。此外，系主任也頒發了 113 年第二學期書卷獎及 113 學年度利他獎給得獎同學，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以電子郵件方式，寄給供師生們參考。



Photo of Department Chair with the Academic Excellence Award Recipients

Students Awards

- PhD Student Jyong-En Miao received the First Place Best Student Hydrology Poster Presentation at 105th AMS Annual Meeting.
- 博士班學生繆炯恩榮獲美國氣象學會水文研討會學生海報論文獎。
- Shih-Pei Hsu and Jie Hsu received the Best Student Poster Competition at 2025 AOGS Annual Meeting.
碩士班學生徐世裴及許桀榮獲 114 年 AOGS 會議最佳學生海報論文獎。
- Yen-Ying Chou received the NSTC College Student Research Creation Award in the 2024 academic year and received helpful guidance from his advisor, Prof. Min-Hui Lo.
周彥廷同學獲得科技部 113 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。
- Yi-Shin Jang, and Jen-Ho Wu received the NTU Altruism Award for the 2024 academic year.
張譯心同學及伍人禾同學獲得 113 學年利他獎。

NTU-U.Tokyo Tropical Pacific Warming Pattern Workshop

From February 11-12, 2025, the Department of Atmospheric Sciences at National Taiwan University (NTU) hosted the NTU-U.Tokyo Tropical Pacific Warming Pattern Workshop. The meeting opened with welcoming remarks by Professor Yen-Ting Hwang from our department and Professor Masahiro Watanabe from the University of Tokyo. Then followed three sessions of research presentations by students from both universities, along with discussions, promoting academic exchange and collaboration.

本系於 114 年 2 月 11-12 日在系館舉辦台大與東京大學實驗室雙邊交流工作坊，會議首先由本系黃彥婷教授與東京大學 Masahiro Watanabe 教授開場，接著由雙邊實驗室的學生分三個場次進行專題論文演講，促進雙邊學術交流。



Group photo of participants from NTU and the University of Tokyo



Group photo taken during the NTU-U.Tokyo Tropical Pacific Warming Pattern Workshop

MEETING HIGHLIGHTS

2025 UAW Workshop on Weather in the Changing Climate

From July 14 to 16, 2025, the Department of Atmospheric Sciences at National Taiwan University (NTU) hosted the University Allied Workshop on Weather in the Changing Climate (UAW 2025) at the Shih-Liang Hall International Conference Center. Continuing the long-standing collaboration between NTU and the University of Tokyo, this year's workshop also welcomed student participants from Tohoku University, bringing together over 50 faculty members and students for three days of in-depth academic exchange and dialogue.

Since its inception in 2015, the UAW has been jointly organized by the Atmosphere and Ocean Research Institute (AORI) of the University of Tokyo and NTU's Department of Atmospheric Sciences on a biennial basis. It aims to promote research collaboration and student training on topics such as climate change, extreme weather, cloud microphysics, and numerical modeling. UAW 2025 marks the first in-person gathering at NTU since the COVID-19 pandemic and the first time that Tohoku University has formally joined, broadening both the scale and depth of academic engagement.

A Rich and Multi-Faceted Agenda Showcasing Taiwan–Japan Research Strengths

Centered on the theme “Weather in the Changing Climate,” the three-day program featured six oral sessions, two poster exhibitions, four student breakout groups, banquet receptions, and a field visit. Topics covered included global high-resolution model development, tropical cyclones and extreme rainfall, convection–circulation coupling in a changing climate, and the use of artificial intelligence in climate research—highlighting the breadth and depth of work conducted by the Japanese and Taiwanese teams.

Several distinguished faculty members presented their latest findings, such as Prof. Masaki Satoh (University of Tokyo), who introduced the EarthCARE satellite project and recent efforts in global storm-resolving model intercomparison. NTU Professors I-I Lin and Ming-Jen Yang gave presentations on projected changes in tropical cyclones under climate warming and new observational results from the TAHOPE campaign on heavy rainfall, respectively. Prof. Chien-Ming Wu also introduced a theoretical framework linking buoyancy and atmospheric convection. The poster sessions, held in the Astronomy–Mathematics Building, featured over 22 student-led projects spanning cloud–radiation interactions, convective system prediction, and machine learning applications—showcasing the promise of the next generation of atmospheric scientists.

Deepening Taiwan–Japan Collaboration and Nurturing Future Talent

A key tradition of the UAW, the student breakout discussions, was carried out in this year's program. Over 30 graduate students and early-career researchers were divided into four groups, engaging in cross-institutional discussion on the following topics:

- How far can Earth system models represent the complexity and feedbacks of the entire Earth system?
- How is global warming changing the nature of extreme weather events, and how can high-resolution models help us understand them?
- How can artificial intelligence advance climate research, and how can it be integrated with traditional modeling approaches?
- What kinds of observational strategies and technologies are needed to advance climate change studies?

These group discussions were held on the afternoon of the second day, with each group presenting their conclusions during a special session on the third morning. The session sparked vibrant discussion and was regarded as one of the most engaging highlights of the conference.

Beyond academic exchange, the workshop also included a field visit for Japanese participants to the Meteorological Instruments Calibration Center at Taiwan's Central Weather Administration, offering a close-up view of Taiwan's observational infrastructure. A welcome banquet and faculty dinner further fostered informal interaction and strengthened collegial ties among participants.

A total of 39 NTU participants joined the event, including 9 professors, 12 Ph.D. students, 9 master's students, and 9 research staff (including postdocs and assistants). The University of Tokyo and Tohoku University contributed 12 participants, representing a broad range of academic levels. This successful event not only upheld the spirit of the UAW series but also marked a significant milestone—the 10th anniversary of the workshop—and laid a stronger foundation for future collaboration and knowledge exchange between Taiwan and Japan.

The next UAW is expected to take place in 2027 at the University of Tokyo's AORI, continuing the momentum of international cooperation in weather and climate science.

2025 年 7 月 14 日至 16 日，由臺灣大學大氣科學系主辦之 University Allied Workshop on the Changing Climate (UAW 2025) 於臺大思亮館國際會議中心盛大舉行。本次研討會延續東京大學與臺灣大學長年以來的合作交流傳統，並邀請來自日本東北大學的學生共同參與，總計超過 50 位師生齊聚一堂，進行為期三日的深入交流與對話。

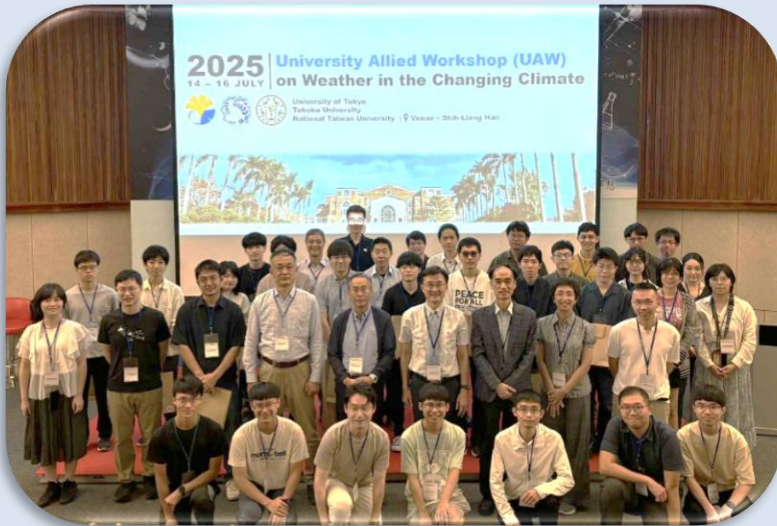
UAW 研討會自 2015 年起由東京大學大氣海洋研究所（AORI）與臺大大氣科學系每兩年輪流主辦，旨在促進兩校於氣候變遷、極端天氣、雲微物理與數值模式等議題上的研究合作與人才培育。2025 年為新冠疫情後首次回歸臺大舉辦，亦是首度納入東北大學的跨校參與，擴大交流規模與深度。

本屆會議以「Weather in the Changing Climate」為主題，三日議程共安排六場主題場次、兩場海報發表、四組學生分組討論與報告以及晚宴交流與實地參訪。報告主題涵蓋全球高解析模式發展、熱帶氣旋與極端降水、氣候動力與對流環流耦合、AI 於氣候研究之應用等，展現台日雙方團隊於各領域的深厚研究基礎。多位教授與研究人員分享最新成果，例如東京大學佐藤正樹教授（Masaki Satoh）介紹 EarthCARE 衛星計畫與全球風暴解析模式比較；臺大大氣系林依依教授與楊明仁教授則分別報告氣候暖化下熱帶氣旋變化與 TAHOPE 劇烈降雨觀測實驗的最新分析成果，吳健銘教授則提出連結浮力與大氣對流的理論框架研究。學生海報發表更是踴躍，在天文數學館的一樓大廳共展示超過 22 件海報，涵蓋雲輻射交互作用、對流系統預測、機器學習模型應用等研究，展現年輕世代的研究潛力。

學生們於第二天下午進行分組研討，第三日上午發表成果簡報，並由主持教授與與會者共同給予回饋，成為會議中最具活力的亮點之一。除了學術交流，本次活動亦安排實地參訪，邀請日方來賓參觀中央氣象署氣象儀器檢校中心，實際了解臺灣觀測技術發展。會議期間亦設有歡迎晚宴與教師聚餐，提供輕鬆交流環境，增進各方夥伴關係。

MEETING HIGHLIGHTS

臺大此次共有 39 位師生參與，包括教授 9 人、博士生 12 人、碩士生 9 人與研究員、研究助理、博士後等研究人員 9 人；東京大學與東北大學則共 12 位與會者，涵蓋教授、博士後、碩博士生等不同層級。本次研討會的圓滿舉行不僅延續 UAW 系列活動的精神，達成十週年的重要里程碑，也為未來台日合作與國際青年學者之間搭建了更穩固的橋樑。預期下屆 UAW 將再次於 2027 在東京大學 AORI 舉行，持續推動氣候與天氣研究之國際協作與知識傳承。



Group photo of all UAW 2025 participants taken in the auditorium of the Shih-Liang Hall International Conference Center, NTU.



Student poster session held in the lobby of the Astronomy–Mathematics Building, featuring lively discussions and active engagement.



Student breakout group presentations (top); Prof. Masaki Satoh of the University of Tokyo in conversation with students (bottom left); souvenirs presented to student volunteers and organizing staff at the closing session (bottom right).

MEETING HIGHLIGHTS



On Day 3, Japanese guests visited the CWA New Taipei Station and the Meteorological Instruments Calibration Center.

NTU/CWA-St-Andrews Joint 2025 Workshop

Since 2022, National Taiwan University (NTU) and the University of St Andrews have been partner universities. Under this partnership, the **NTU–University of St Andrews Joint Seed Funding** was launched for the first time in autumn 2024, aiming to support early-stage collaboration and foster future research and academic innovation. In the same year, **Dr. Simon Lee** joined the School of Earth and Environmental Sciences at the University of St Andrews as a Lecturer. Simon and I had been collaborating since 2021—when I joined the Department of Atmospheric Sciences at NTU—on a study applying machine learning to characterize the spatiotemporal evolution of sudden stratospheric warming, an extreme dynamical event in the stratosphere. Upon learning about the new seed funding opportunity, Simon informed me, and together we began preparing a proposal building on our previous work in stratospheric dynamics.

One recommendation in the proposal call was to strengthen collaboration between universities and operational centres. In response, we reached out to the Central Weather Administration (CWA) in Taiwan, and **Dr. Yun-Lan Chen** joined our team to help establish a connection between NTU, the University of St Andrews, and CWA. Notably, the current CWA extended-range forecast system has not yet been systematically evaluated for its performance in representing stratospheric circulation. Our proposal incorporates this assessment, and the results are expected to provide valuable guidance for improving CWA’s extended-range forecasting capability. We also invited **Dr. Ioana Colfescu** to collaborate, given her expertise in climate prediction and machine learning.

To support communication, accelerate research progress, and promote educational exchange between the two universities, we organized the **NTU/CWA–St Andrews Joint 2025 Workshop** from **2–5 September 2025** at both the Department of Atmospheric Sciences at NTU and the CWA. The first day featured scientific seminar presentations by **Dr. Simon Lee** and **Dr. Ioana Colfescu** from the University of St Andrews. In the same week, **Dr. Maxime Collin** (Leibniz Centre for Tropical Marine Research, Germany) and **Dr. Wei-Ming Tsai** (UCLA) also visited the Department of Atmospheric Sciences at NTU. We coordinated their visits so that all four presentations formed a seminar series on the afternoon of the first day. The event attracted strong interest from students, researchers, and faculty members at NTU, with approximately 100 attendees (see Figure 1). Importantly, the invited scientists introduced new research perspectives—particularly on mid- and high-latitude climate change—bringing fresh ideas and vibrant academic energy into our department.

MEETING HIGHLIGHTS

The second day featured two lectures by **Dr. Simon Lee** and **Dr. Ioana Colfescu**, who introduced foundational concepts in stratospheric atmospheric dynamics and demonstrated approaches for decadal prediction using machine learning to students in our department. Following the lectures, they joined students for lunch and extended informal discussions. In the afternoon, Dr. Lee and Dr. Colfescu met individually with faculty members for in-depth conversations on ongoing research, potential collaborations, and opportunities for future educational exchange with the University of St Andrews.

The third day coincided with the **39th Conference on Weather Analysis and Forecasting** at the Central Weather Administration (CWA). We arranged two plenary talk sessions for **Dr. Simon Lee** and **Dr. Ioana Colfescu**, during which they delivered operationally oriented presentations to CWA staff and exchanged ideas on enhancing CWA's prediction system beyond the weather timescale (see Figure 2). On the fourth day, we concluded the workshop with a closed-door meeting involving the CWA deputy and the technical team participating in this project. The discussion focused on future research directions and opportunities for continued collaboration between NTU, CWA, and the University of St Andrews.

The workshop was highly successful, not only in establishing a strong foundation for future educational and research collaborations between NTU and the University of St Andrews, but also in demonstrating the value of international university partnerships. We look forward to more frequent and meaningful interactions between the two institutions in the coming years. Finally, we sincerely appreciate the support from the NTU–University of St Andrews Joint Seed Funding, the Office of International Affairs, and the Department of Atmospheric Sciences at NTU.

--Yu-Chiao Liang

自 2022 年起，國立臺灣大學（NTU）與英國聖安德魯斯大學（University of St Andrews）成為姊妹校。在此合作架構下，NTU – 聖安德魯斯大學聯合種子研究經費（Joint Seed Funding）於 2024 年秋季首次啟動，旨在支持早期研究合作並促進未來的研究與學術創新。同年，Simon Lee 博士加入聖安德魯斯大學地球與環境科學學院（School of Earth and Environmental Sciences），擔任講師。我與 Simon 自 2021 年起便展開合作，當時我加入臺大大氣科學系，我們共同進行一項研究，運用機器學習方法來刻畫平流層突發增溫（sudden stratospheric warming）這一平流層中極端動力事件的時空演變特徵。在得知新的種子研究經費徵案後，Simon 立即通知我，並與我一同開始籌備一項延續既有平流層動力學研究基礎的研究計畫。

計畫徵案中特別建議加強大學與作業單位之間的合作，因此我們主動聯繫中央氣象署（CWA），並邀請陳韻嵐博士加入團隊，協助建立臺大、聖安德魯斯大學與中央氣象署之間的合作連結。值得注意的是，中央氣象署現行的延伸期預報系統尚未針對其平流層環流表現進行系統性評估。我們的研究計畫納入了此一評估工作，相關成果預期將為提升中央氣象署延伸期預報能力提供重要參考。此外，我們也邀請了在氣候預報與機器學習領域具備專長的 Ioana Colfescu 博士共同參與合作。

為了促進溝通、加速研究進展，並推動兩校之間的教育交流，我們於 2025 年 9 月 2 日至 5 日在臺大大氣科學系及中央氣象署共同舉辦「2025 年 NTU/CWA – 聖安德魯斯聯合工作坊」。工作坊首日安排了由聖安德魯斯大學的 Simon Lee 博士與 Ioana Colfescu 博士進行的學術演講。同一週內，來自德國萊布尼茲熱帶海洋研究中心（Leibniz Centre for Tropical Marine Research）的 Maxime Collin 博士，以及來自加州大學洛杉磯分校（UCLA）的蔡威銘博士，也造訪了臺大大氣科學系。

MEETING HIGHLIGHTS

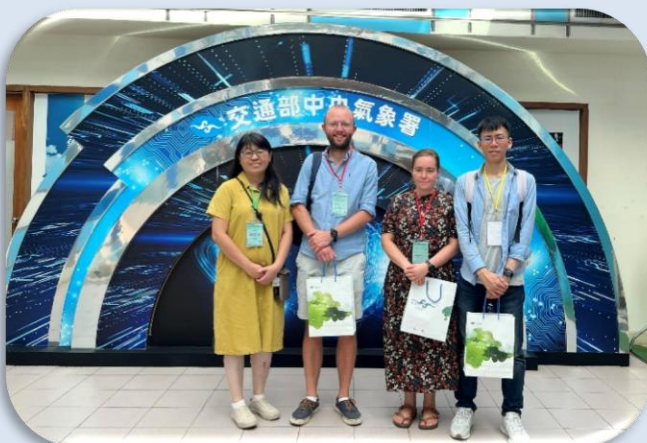
我們協調了他們的行程，使四場演講於首日下午共同組成一系列學術研討會。該活動吸引了臺大學生、研究人員與教師的熱烈參與，約有 100 人出席（見圖一）。更重要的是，受邀學者帶來了嶄新的研究視角，特別是在中高緯度氣候變遷方面，為本系注入新的研究想法與蓬勃的學術活力。

第二天安排了由 Simon Lee 博士與 Ioana Colfescu 博士主講的兩場課程，向本系學生介紹平流層大氣動力學的基礎概念，並示範如何運用機器學習進行年代際尺度的預測。課程結束後，兩位講者與學生共進午餐，並進行延伸且深入的非正式交流。下午，Lee 博士與 Colfescu 博士分別與系上教師進行一對一會談，就目前進行中的研究、潛在的合作方向，以及未來與聖安德魯斯大學之教育交流機會展開深入討論。

第三天恰逢中央氣象署（CWA）舉辦第 39 屆天氣分析與預報研討會。我們特別安排 Simon Lee 博士與 Ioana Colfescu 博士各進行一場大會專題演講，兩位學者針對中央氣象署同仁進行以實務應用為導向的報告，並就如何將預報系統能力延伸至天氣尺度以外的預測進行意見交流（見圖二）。第四天，工作坊以一場閉門會議作結，與會者包括中央氣象署副署長及本計畫參與之技術團隊。會議重點聚焦於未來研究方向，以及臺大、中央氣象署與聖安德魯斯大學之間持續合作的可能性與機會。整體而言，本次工作坊成果豐碩，不僅為臺大與聖安德魯斯大學未來在教育與研究上的合作奠定了穩固基礎，也具體展現了國際大學夥伴關係的價值。我們期盼未來兩校之間能有更頻繁且更具深度的交流與合作。最後，謹此誠摯感謝 NTU - 聖安德魯斯大學聯合種子研究經費、國立臺灣大學國際事務處，以及臺大大氣科學系對本次活動的支持。



The photo taken after seminar presentations in day 1 of the workshop. The four in the center front from left to right: Dr. Maxime Collin, Dr. Ioana Colfescu, Dr. Simon Lee and Dr. Yu-Chiao Liang.



The photo taken after seminar presentations in day 3 of the workshop at CWA. The four in the center front from left to right: Dr. Yun-Lan Chen, Dr. Simon Lee, Dr. Ioana Colfescu, and Dr. Yu-Chiao Liang.

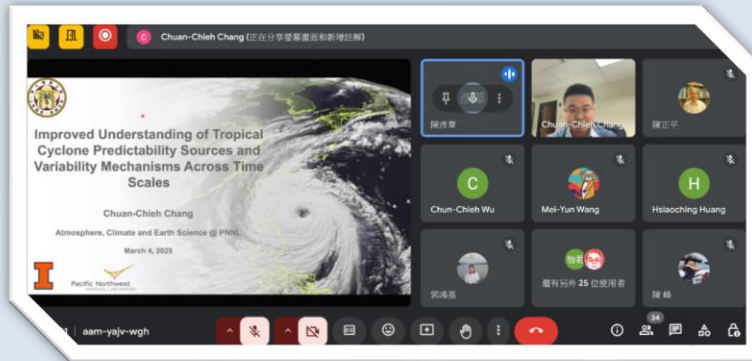
VISITORS



Group photo of seminar on January 2nd, 2025 for the visitor: Yan-Ning Kuo



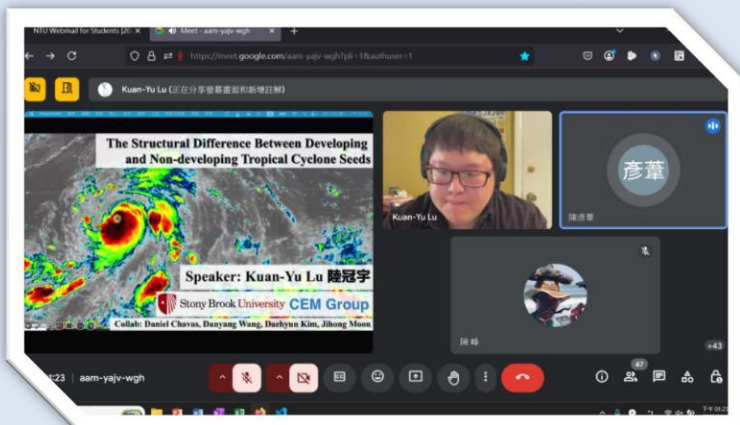
Group photo of seminar on February 18th, 2025 for the visitor: Dr. Thomas Hauser



Group photo of seminar on March 4th, 2025 for the visitor: Dr. Chuan-Chieh Chang



Group photo of seminar on March 6th, 2025 for the visitor: Dr. Frank Li



Group photo of seminar on March 11th, 2025 for the visitor: Dr. Kuan-Yu Lu



Group photo of seminar on March 13rd, 2025 for the visitor: Dr. Mu-Ting Chien

VISITORS



Group photo of seminar on March 18th,
2025 for the visitor: Dr. Buo-Fu Chen



Group photo of seminar on March 20th,
2025 for the visitor: Prof. Yi Huang



Group photo of seminar on April 14th,
2025 for the visitor: Prof. Bo Qiu



Group photo of seminar on May 8th,
2025 for the visitor: Prof. William K. M. Lau
& Prof. Tim Li



Group photo of seminar on May 22nd,
2025 for the visitor: Johnny Chan &
Emeritus Russell Elsberry



Group photo of seminar on June 3rd,
2025 for the visitor: Min-Duan Tzeng

VISITORS



Group photo of seminar on June 9th,
2025 for the visitor: Prof. Hisashi Nakamura



Group photo of seminar on June 19th,
2025 for the visitor: Prof. Yuan Wang & Qiang Fu



Group photo of seminar on June 26th,
2025 for the visitor: Prof. Yi Ming



Group photo of seminar on August 12th,
2025 for the visitor: Dr. Yi-Chien Chen



Group photo of seminar on September 2nd, 2025 for
the visitor: Dr. Simon Lee & Dr. Ioana Colfescu &
Dr. Maxime Collin & Dr. Wei-Ming Tsai



Group photo of seminar on September 9th, 2025
for the visitor: Dr. Slawomir Jack Giletycz

VISITORS



Group photo of seminar on September 16th, 2025 for the visitor: Prof. Hien X. Bui

Predicting and projecting variations in CO₂ fluxes and atmospheric CO₂ using Earth System Models with an interactive carbon cycle

Hongmei Li

Helmholtz-Zentrum Hereon, Germany

Acknowledge: Tatiana Ilyina, Lennart Ramme, Chao Li, Danai Filippou, István Dunkl, Aaron Spring, Sebastian Brune, Wolfgang A. Müller, Peter Landschützer, Frank Sienz, Tamas Loughran, Julia Pongratz, Raffaele Bernardello, Laurent Bopp, Ingo Bethke, Filippa Fransner, Pierre Friedlingstein, Vladimir Lapin, William J. Merryfield, Juliette Mignot, Michael O'Sullivan, Didier Swingedouw, Hiroaki Tatebe, Reinel Sospedra-Alfonso, Jerry Tjiputra, Olivier Torres, Etienne Tourigny, Michio Watanabe.....



Group photo of seminar on September 23rd, 2025 for the visitor: Dr. Hongmei Li



Group photo of seminar on September 30th, 2025 for the visitor: Dr. Chih-Chi Hu



Group photo of seminar on October 9th, 2025 for the visitor: Prof. Masashi Minamide

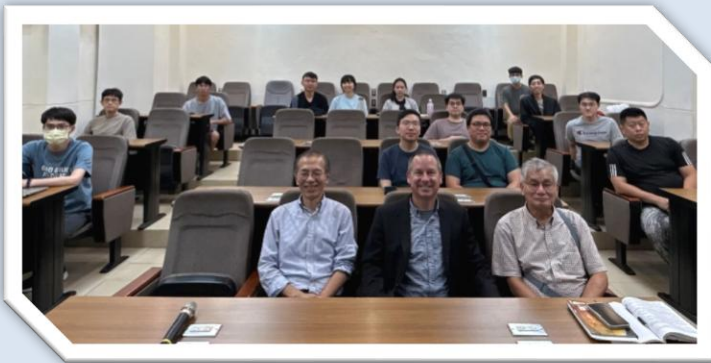


Group photo of seminar on October 9th, 2025 for the visitor: Prof. Yi-Leng Chen



Group photo of seminar on October 14th, 2025 for the visitor: Dr. Mu-Ting Chien

VISITORS



Group photo of seminar on October 15th,
2025 for the visitor: Prof. Michael M. Bell



Group photo of seminar on October 21st,
2025 for the visitor: Prof. James Ruppert



Group photo of seminar on October 28th,
2025 for the visitor: Dr. Daisuke Matsuoka



Group photo of seminar on November 3rd,
2025 for the visitor: Prof. Chih-Pei Chang



Group photo of seminar on November 7th,
2025 for the visitor: Prof. Li-Chyong Chen



Group photo of seminar on November 13th,
2025 for the visitor: Dr. Sarah Lu

VISITORS



Group photo of seminar on November 24th,
2025 for the visitor: Prof. Joost de Gouw



Group photo of seminar on November 27th,
2025 for the visitor: Dr. Craig Schwartz



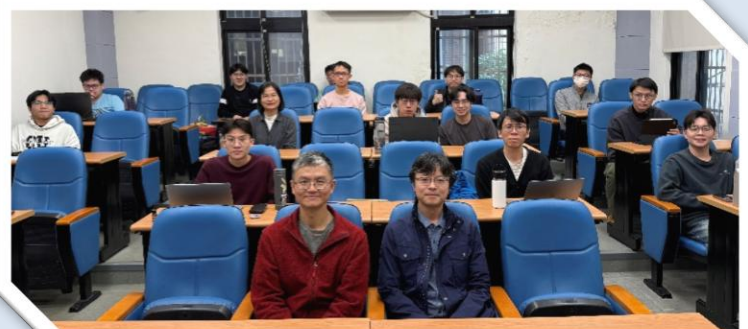
Group photo of seminar on December 4th,
2025 for the visitor: Dr. Chih-Chuan Liu



Group photo of seminar on December 24th,
2025 for the visitor: Prof. Wen-Yih Sun



Group photo of seminar on December 26th,
2025 for the visitor: Bo-Yuan Chen



Group photo of seminar on December 31st,
2025 for the visitor: Prof. Johnny Lo

VISITORS

Date	Speaker	Unit	Title
114/1/2	Yan-Ning Kuo	Earth and Atmospheric Sciences, Cornell University	Detections and attributions for decadal variability under a changing climate and its regional hydroclimate impacts
114/2/18	Dr. Thomas Hauser	NCAR, CISL	Accelerating End-to-End Workflows for Earth System Science
114/3/4	Dr. Chuan-Chieh Chang	PostDoc researcher, Pacific Northwest National Laboratory	Improved Understanding of Tropical Cyclone Predictability Sources and Variability Mechanisms Across Time Scales
114/3/6	Dr. Frank Li	Jet Propulsion Laboratory / NASA	Explore the Linkages Between Tropical Surface Wind Stress, SST, PBL Clouds, and Upper Ocean Currents
114/3/11	Dr. Kuan-Yu Lu	Postdoctoral Researcher, Stony Brook University	The structural difference between developing and non-developing tropical cyclone seeds
114/3/13	Dr. Mu-Ting Chien	Colorado State University	Changes in stratiform heating structure due to surface warming weaken and accelerate convectively coupled Kelvin waves
114/3/18	Dr. Buo-Fu Chen	Center for Weather and Climate Disaster Research, NTU	Toward Understanding Tropical Cyclone Structure Development and Maximum Kinetic Energy Variability with Deep Learning
114/3/20	Prof. Yi Huang	McGill University	Detecting atmospheric radiation trends
114/3/25	Prof. Ralph Toumi	Grantham Institute, Imperial College London	The Imperial College Storm Model (IRIS)
114/3/28	Academician Pao-Kuan Wang	Academia Sinica	大氣科學研究一些經驗談
114/4/14	Prof. Bo Qiu	University of Hawaii	Recent regime shift in the northwestern Pacific Ocean and climate system
114/4/29	Prof. Kai-Wei Chang	Chinese Culture University	Distribution, mechanisms, and variability of tropopause folds
114/5/8	Prof. William K. M. Lau	ESSIC, University of Maryland	Why Record-Breaking Extreme Precipitation Events Occur Preferentially over Land
114/5/9	Prof. Tim Li	University of Hawaii	MJO Moisture Mode Dynamics and ENSO Intensity/Initiation Diversity
114/5/22	Prof. Russell Elsberry	Naval Postgraduate School	Research Opportunities to Improve Understanding and Predicting an Unfavorable TC Environment
114/5/22	Prof. Johnny Chan	City University of Hong Kong	Three-Dimensional Fujiwhara Effect

Date	Speaker	Unit	Title
114/5/29	Dr. Yong-Fu Lin	Academia Sinica	An Atlantic-driven rapid circulation change in the North Pacific Ocean
114/6/3	Min-Duan Tzeng	University of Oklahoma	Orthogonal Waveform Multiplexing for Dual-Pol Weather Radar
114/6/9	Prof. Hisashi Nakamura	University of Tokyo	ClimCORE Project and Group Discussion & Factors for a climatological early-spring peak of cyclone activity in East Asia
114/6/19	Prof. Yuan Wang	Stanford University	Dusty Hurricanes
114/6/19	Prof. Qiang Fu	University of Washington	From Enhanced Arctic Amplification to Tropical Pacific Cooling
114/6/26	Prof. Yi Ming	Boston College	Harnessing Weather-Climate Science for Societal Resilience
114/8/12	Dr. Yi-Chien Chen	Nagoya University	Convective Evolution over Tropical Oceans
114/8/13	Mr. Bruno Rojas	Penn State University	Tropical Cyclone Eyewall Ice Crystals
114/9/2	Dr. Simon Lee	University of St Andrews	Pacific centre-of-action of the Northern Annular Mode
114/9/2	Dr. Ioana Colfescu	University of St Andrews	Beyond Stationarity: ML and North Atlantic Behaviour
114/9/2	Dr. Maxime Collin	ZMT, Germany	Short-term memory in the climate system
114/9/2	Dr. Wei-Ming Tsai	UCLA	Tropical convective organization
114/9/9	Dr. Slawomir Jack Giletycz	Department of Earth Sciences, NCU	Recent scientific advances from the Taiwan Arctic Research Station (Svalbard): Insights into high-latitude environmental change
114/9/16	Prof. Hien X. Bui	Department of Atmospheric Sciences, NCU	Responses of the MJO to global warming: Impacts from tropical SST changes
114/9/22	Dr. Satoshi Inomata	NIES, Japan	Measurements of reactive nitrogen and NMVOCs in Tokyo
114/9/23	Dr. Hongmei Li	Helmholtz-Zentrum Hereon	Variations in CO ₂ fluxes and atmospheric CO ₂
114/9/30	Dr. Chih-Chi Hu	Princeton University	Advancing Non-Gaussian Data Assimilation
114/10/9	Prof. Yi-Leng Chen	University of Hawaii	Large-scale flow regimes during PRECIP
114/10/9	Prof. Masashi Minamide	University of Tokyo	Predictability of Moist Convection
114/10/14	Dr. Mu-Ting Chien	Boston University	Tropical cyclone frequency from paleo to present

VISITORS

Date	Speaker	Unit	Title
114/10/15	Prof. Michael M. Bell	Colorado State University	Relationships between Rotation and Rainfall
114/10/21	Prof. James Ruppert	University of Oklahoma	Cloud greenhouse effect and stratiform paradox
114/10/28	Dr. Daisuke Matsuoka	JAMESTAC, Japan	Data-driven approaches in weather prediction and climate resilience
114/11/7	Prof. Li-Chyong Chen	Department of Physics, NTU	讓夢想起飛：邁向兩性共好
114/11/13	Dr. Sarah Lu	University at Albany, SUNY	Advancing predictability of atmospheric composition
114/11/24	Prof. Joost de Gouw	University of Colorado Boulder	Emissions and Chemistry of VOC
114/11/27	Dr. Craig Schwartz	NCAR MMM Lab	Storm-scale forecasts with MPAS
114/12/4	Dr. Chih-Chuan Liu	NCAR	Ensemble assimilation of dual-pol radar data
114/12/24	Prof. Wen-Yih Sun	Purdue University	Effect of terrain on blocking and downslope wind
114/12/26	Bo-Yuan Chen	Technical University of Munich (TUM)	比方說，我辭掉了工作，跑去歐洲讀第二個碩士
114/12/31	Prof. Johnny Luo	City University of New York	Strong Coupling between Latent Heating and Convective Vertical Velocity

How Fine-Scale Details Reshape the Tropical Energy Flow

The Big Picture: Earth's Global Heat Engine

Earth's atmosphere is essentially a giant heat engine. The tropics soak up an enormous amount of solar energy, which the atmosphere then transports toward the cooler poles. This movement of energy is what keeps our planet's climate in balance, preventing the equator from becoming an unlivable furnace and the poles from being even more frozen.

For decades, scientists have used computer simulations—General Circulation Models (GCMs)—to predict how this energy moves. However, the tropics have always been a "trouble spot" for these models. Because the tropics are dominated by small-scale features like individual thunderstorms and clouds (convection) that are often smaller than a single grid square in a model, we've had to rely on simplified "recipes" called parameterizations to represent them.

Our Approach: The "Aquaplanet" Laboratory

In our study, we wanted to see what happens when we remove those simplified recipes and let the model "see" the weather more clearly by increasing the horizontal resolution. We used two "aquaplanets"—simplified models of Earth covered entirely by water—to strip away the complications of mountains and continents. We tested resolutions ranging from a coarse 300 kilometers (where a single data point represents the size of a large state) down to a sharp 6 kilometers (fine enough to start seeing individual storm structures).

What We Discovered

We found that as the resolution gets finer, the way the atmosphere moves energy in the tropics changes dramatically, even though the total amount of energy being moved stays roughly the same.

1. **The Rise of the Hadley Cell:** In higher-resolution models, the "mean circulation" (the large-scale rising and falling of air known as the Hadley Cell) becomes much more efficient at carrying energy poleward. It becomes "top-heavy," with more air moving at very high altitudes where it carries the most energy.
2. **The Fade of the "Eddies":** Conversely, at lower resolutions, the models rely on "transient eddies"—temporary, swirling weather systems—to do the heavy lifting. As resolution improves, these eddies play a much smaller role in the deep tropics.

Why It Matters

Our results show that increasing a climate model's resolution isn't just about making the picture "sharper"—it actually changes the fundamental physics of how the tropics function.

We demonstrate that looking at total energy transport alone isn't enough to judge if a model is working correctly. If two models show the same total heat moving poleward but achieve it through different mechanisms—one through planetary-scale steady winds and the other through synoptic-scale swirling storms—they may react very differently as the planet warms. In fact, we currently lack a clear consensus on which of these two mechanisms should play the dominant role even in our present-day climate!

As the scientific community moves toward "storm-resolving" models to predict our future climate, our work provides a vital benchmark for how tropical processes scale across different resolutions. By identifying how the Hadley Cell and transient eddies trade off duties on finer grids, we can better calibrate the next generation of models to provide more reliable predictions for tropical and global climate change.

誰才是熱帶能量的搬運主力？模式解析度揭開環流與渦旋的地位爭奪戰

地球就像一台巨大的熱機，熱帶地區吸收了大量的太陽能量，並透過大氣運動將其輸送到寒冷的兩極，維持了地球溫度的穩定。長期以來，科學家使用全球氣候模式（GCMs）來模擬這項過程，但熱帶地區的小規模氣候特徵（如雷陣雨和雲層）一直是大規模模型難以精確捕捉的「痛點」，必須依賴簡化的公式（參數化）來填補解析度的不足。在我們的研究中，我們使用了「水球行星」（Aquaplanet，即假設地球表面完全被海洋覆蓋）簡化模式，並將模擬解析度從 300 公里提升至 6 公里，這讓模式能更清晰地「看到」並計算大氣運動，而非由簡化公式推測。

研究發現，隨著解析度提高，雖然總能量輸送量保持穩定，但大氣搬運能量的「方式」發生了根本性轉變。在高解析度下，行星尺度的大規模哈德里環流（Hadley Cell）變得更有效率，能量主要透過高空的穩定氣流輸送；相比之下，低解析度模型則主要依賴綜觀尺度的旋轉天氣系統（瞬時渦旋）來搬運熱量。這項發現提醒了我們，評價一個氣候模式不能只看它預測的能量傳送「總數」，更要看其背後的物理機制是否正確。事實上，即便在當前的氣候條件下，科學界對於環流與渦旋這兩種機制究竟孰輕孰重，也還沒有一個基礎性的理解！隨著氣候預測邁向「風暴解析」時代，這項研究為我們理解熱帶大氣動力如何隨解析度演變提供了關鍵基準，並對於未來更精確地預測熱帶及全球的氣候變遷又向前邁出了一小步。

Title: Resolution Dependence of Tropical Poleward Energy Transport in Aquaplanet GCMs

Authors: Chiung-Yin Chang, Pu Lin, Isaac M. Held, Timothy M. Merlis, and Pablo Zurita-Gotor

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Can a sounding predict afternoon thunderstorms? A TaiwanVVM-based framework for uncovering the role of boundary layer dynamics

A sounding is typically used to diagnose the thermodynamic properties of the atmosphere. A classical parcel model is generally used to assess the potential for convective development (i.e., through CAPE/CIN diagnoses). However, it is well known that under the diurnal cycle over land, the development of shallow convection within the boundary layer can strongly influence the onset of deep convection (Wu et al. 2009). In addition, the horizontal heterogeneity of surface sensible and latent heat fluxes, shaped by previous convective events, can significantly modify both the mean precipitation and the timing of peak rainfall during the diurnal cycle (Wu et al. 2015). These findings highlight the critical role of boundary layer processes in predicting afternoon thunderstorms. Over a mountainous island such as Taiwan, this environmental information, combined with strong orographic forcing and locally driven circulations, provides an even stronger constraint on the formation of precipitation hotspots associated with orographically locked convection. This provides an opportunity to predict afternoon thunderstorms in numerical simulations using only soundings that represent the upstream large-scale environment.

In TaiwanVVM, orographic effects are embedded in the vorticity equation, resulting in a non-local flow structure that is essential for capturing these precipitation hotspots. The flow-dependent orographic effects (Wu and Arakawa 2011; Wu et al. 2019) enable the simulation of local circulations generated by buoyancy gradients while minimizing contamination by numerical diffusion. We demonstrate that the formation and intensity of these hotspots strongly depend on interactions among the physical processes governing local energetics and cloud dynamics. Accurately estimating future changes in these hotspots therefore requires a model with sufficiently high spatial resolution as well as an appropriate representation of the key physical processes.

Ensembles of TaiwanVVM large-eddy simulations ($\Delta x = 500$ m) are designed to capture summertime diurnal convection over Taiwan under conditions dominated by local circulation (Chen et al. 2024). Precipitation hotspots identified from long-term observations are well reproduced by the present-day ensemble simulations when realistic environmental variability is included. A pseudo-global warming experiment is then conducted to examine changes in convective structures and the resulting local rainfall responses. Under a uniform warming scenario of 3 K with conserved relative humidity, the thermodynamic environment exhibits increased convective available potential energy and a slight reduction in convective inhibition (CIN), primarily due to enhanced low-level water vapor in the marine boundary layer. These

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high-resolution simulations, conducted under a well-defined weather regime, provide critical information for assessing future changes in extreme rainfall associated with orographically locked diurnal convection, with implications for natural hazards and water resources.

Furthermore, the robustness of the TaiwanVVM ensemble dataset can be leveraged to train an AI model that can substantially accelerate prediction while preserving physical explainability through a variational autoencoder (VAE; e.g., Hsieh and Wu 2024). By compressing the TaiwanVVM results into a small number of latent dimensions, we can project and interpret key physical processes within this reduced space. With the aid of a large number of TaiwanVVM ensemble simulations, we can develop an AI-TaiwanVVM framework that generates local flow and precipitation patterns using only upstream soundings as input.

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探空能否預測午後雷雨？——以 TaiwanVVM 為基礎的框架揭示邊界層動力的關鍵角色

探空資料通常用於診斷大氣的熱力學性質。經典的氣塊模型一般用來評估對流發展的潛勢（即透過 CAPE/CIN 的診斷）。然而，眾所周知，在陸地的日變化循環下，邊界層內淺對流的發展能夠顯著影響深對流的觸發（Wu et al. 2009）。此外，由先前對流事件所形塑的地表感熱與潛熱通量之水平異質性，也能在日變化循環中顯著改變平均降水量以及尖峰降雨出現的時間（Wu et al. 2015）。

這些研究結果突顯了邊界層過程在預測午後雷雨中的關鍵角色。對於像臺灣這樣的多山島嶼而言，這些環境資訊若再結合強烈的地形強迫與局地驅動的環流，將對與地形鎖定對流相關的降水熱點形成提供更強的約束。這也為在數值模擬中僅使用代表上游大尺度環境的探空資料來預測午後雷雨提供了可能性。

在 TaiwanVVM 中，地形效應被嵌入渦度方程式中，從而產生一種非局域的流場結構，而這對於捕捉這些降水熱點至關重要。流場依賴的地形效應 (Wu and Arakawa 2011; Wu et al. 2019) 使模式能夠模擬由浮力梯度所驅動的局地環流，同時將數值誤差的影響降至最低。我們證明，這些降水熱點的形成與強度高度依賴於支配局地能量學與雲動力學之物理過程間的交互作用。因此，若要準確估計這些熱點在未來的變化，必須使用具有足夠高空間解析度且能適當表現關鍵物理過程的模式。

我們設計了一系列 TaiwanVVM 大渦模擬 ($\Delta x = 500 \text{ m}$) 的集合，以捕捉在局地環流主導條件下，臺灣夏季的日變化對流 (Chen et al. 2024)。長期觀測所識別的降水熱點，在納入真實環境變異性後，能被現今氣候條件下的集合模擬良好再現。隨後，我們進行一項假想全球暖化 (pseudo-global warming) 實驗，以檢視對流結構的變化及其對局地降雨的影響。在相對濕度維持不變、均勻升溫 3 K 的情境下，熱力環境呈現出對流可用位能 (CAPE) 的增加與對流抑制 (CIN) 的輕微減弱，主要源於海洋邊界層低層水汽的增加。這些在明確氣象型態下進行的高解析度模擬，為評估與地形鎖定日變化對流相關的極端降雨未來變化提供了關鍵資訊，並對自然災害與水資源管理具有重要意涵。

此外，TaiwanVVM 集合資料的穩健性可用於訓練一個 AI 模型，透過變分自編碼器 (VAE; 例如 Hsieh and Wu 2024) 在大幅加速預測的同時保留物理可解釋性。透過將 TaiwanVVM 的結果壓縮至少數潛在維度，我們可以在此降維空間中投射並詮釋關鍵物理過程。藉由大量 TaiwanVVM 集合模擬的協助，我們可發展出 AI-TaiwanVVM 框架，僅以上游探空資料作為輸入，即可生成局地流場與降水型態。

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Doctoral Theses

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■ Jin De Huang 黃金德	A Hierarchical Understanding of Physical Processes Modulating Convective Aggregation Using the Vector Vorticity Equation Cloud-Resolving Model 利用向量渦度方程雲解析模型階層式探討影響對流聚集之物理過程
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■ Tsubaki Hosokawa 細川椿	Kinematics and Microphysics of Orographically Enhanced Precipitation Associated with Different Types of Tropical Cyclone Background Precipitation 不同熱帶氣旋背景降水類型下地形加強降水的運動場特徵與微物理機制

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■ David Tao 陶昱丞	The Relation between Tropical Cyclone Structure Evolution and Intensity Under Moderate Vertical Wind Shear 中等垂直風切下熱帶氣旋結構演變與初始強度的關係

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■ Hao-Hsun Hsueh 薛皓薰	Establishing Early Warning Precursors for Afternoon Convection in the Chiayi Area Using TaiwanVVM Large-Eddy Simulation Ensemble 以 TaiwanVVM 大渦模擬系集建立嘉義地區午後對流之預警前兆
■ Feng Chen 陳峰	Formation and Evolution of Organic Aerosols in Xitun Urban Area, Central Taiwan 東亞季風春夏轉換期降雨和環流特徵及南海與周圍區域氣候季內震盪之辨識
■ Bo-Jhih Hsiao 蕭柏智	Investigating the role of Ocean Barrier Layer on Tropical Cyclone Evolution 海洋屏障層對颱風發展的影響之探討
■ Chia-Le Chen 陳迦勒	A Study on Tropical Cyclone Structure Evolution and Variability with Deep Learning 深度學習於熱帶氣旋結構演變與變異度之研究
■ Yi-Jyun Liao 廖奕鈞	Extended Range Forecasting Capabilities of Western North Pacific Tropical Cyclone Events by DWP Models 深度學習模式對西北太平洋熱帶氣旋事件的展期預報能力
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