National Taiwan University
Department of Atmospheric Sciences

Newsletter

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CONTENT

Honors and Awards

- Prof. I-I Lin received the Editor Award of BAMS in 2022.

- Prof. Cheng-Ku Yu received the NSTC Outstanding Research Award in 2021.

- Prof. Yen-Ting Huang received the NSTC Ta-Yu Wu Memorial Award in 2022.

- Prof. Kai-Chih Tseng received the Yushan Young Fellow Award by the Ministry of Education.

- Prof. Hung-Chi Kuo was elected as Fellow of Taiwan Society for Industrial and Applied Mathematics (TWSIAM) in 2020.

- Prof. Chun-Chieh Wu translated the book "Devine Wind: The History and Science of Hurricanes", which was reprinted by NTU Press in 2022.

- Prof. Min-Hui Lo was promoted to Professor on August 1, 2022.

- 林依依教授榮獲美國氣象學會編輯獎（Editor Award of BAMS）(2022 年)。

- 游政谷教授榮獲 110 年度科技部傑出研究獎。

- 黃彥婷副教授獲得國科會 111 年度「吳大猷先生紀念獎」。

- 曾開治老師獲得教育部玉山青年學者獎助。

- 郭鴻基教授榮獲台灣工業與應用數學會首屆會士(109 年度)。

- 吳俊傑教授翻譯書籍《颱風》於臺大出版中心再版 (2022 年)。

- 羅敏輝老師自 111 年 8 月起升等教授。

Personnel Changes

- Prof. Kai-Chih Tseng joined the department faculty since August 1st, 2022.

- Project Assistant Prof. Stephen M. Griffith joined the department faculty since August 1st, 2022.

- 曾開治老師自 111 年 8 月 1 日起到系服務。

- 谷邁世專案助理教授自 111 年 8 月 1 日起到系服務。

Prof. Kai-Chih Tseng joined the Department Faculty
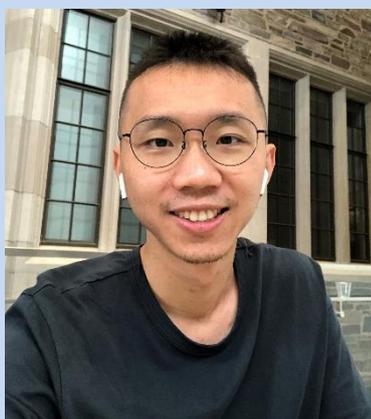
個人介紹 Self-introduction:

個人喜歡研究一些新的數學方法在流體力學/氣候動力上的應用，目前研究著重在結合統計力學、機器學習以及大尺度氣候動力探討極端天氣的可預報度。舉例來說：如何用機器學習去近似 Liouville equation 解析解進而產生無限多組的系集天氣預報，測試極端天氣發生的機率以及計算對應的空間結構。閒暇之餘也喜歡動手寫氣候模式、學新的程式和資料分析方法。

學歷 Education：

科羅拉多州立大學大氣科學系博士 2016-2019

Ph.D. in Atmospheric Science, Colorado State University, 2016-2019

經歷 Experience：

普林斯頓大學大氣與海洋科學系　　　　　博士後 2019-2022

美國海洋大氣總署地物流力實驗室　　　　博士後 2019-2022

Postdoc in Atmospheric and Oceanic Sciences, Princeton University/NOAA Geophysical Fluid Dynamics Laboratory, 2019-2022

專長 Expertise or Research Interests ：

動力系統模型與機器學習、大尺度氣動力、極端天氣展期預報/氣候變遷

Dynamical System Analysis and Machine Learning, Large-scale dynamics, Extended-range forecast of extremes, Climate Change

Project Assistant Prof. Stephen M. Griffith joined the Department Faculty

學歷 Education:

Ph.D. Indiana University - Bloomington 2013

經歷 Experience:

National Taiwan University, Dept. of Atmospheric Sciences, Project Assistant Professor   2022 ~ Present

National Central University, Dept. of Atmospheric Sciences, Assistant Research Fellow   2018 ~ 2022

專長 Expertise or Research Interests:

Atmospheric chemistry, gas-phase radical chemistry, tropospheric ozone production, aerosol composition and source apportionment

個人介紹 Self-introduction:

I have been interested in the environment from a young age, both to experience the wonders of what our natural environment has to offer and to understand and preserve it for the future. I then integrated my chemistry knowledge into my interest in the environment and now analyze the detailed chemistry occurring all around us in the air we breathe. I teach atmospheric environment courses with the goal of inspiring students to deeply appreciate Earth's atmosphere and its importance as a crucial reservoir of important chemical compounds and an arena for exciting chemistry! I also teach graduate writing courses to help guide students towards submission in an academic journal. My research focuses on the measurement, analysis, and simulation of gas-phase and aerosol pollution. Currently, my measurements are centered around tropospheric ozone production and the underlying radical chemistry, where much of it is powered by the complex suite of organic chemicals in the atmosphere. I also analyze the chemical composition and chemistry of aerosols and clouds to apportion the sources of their chemical components and detail their interaction with gas-phase compounds. Finally, I use 0-D and 1-D models to simulate the explicit gas-phase chemistry and exchange with dry and wet aerosol surfaces.

NTU Azalea Festival

Due to the COVID-19 pandemic's impact on Taiwan, the Azalea Festival was held online on March 12th and 13th, 2022. While cooperating with epidemic prevention measures, the opening ceremony and department exhibition were live-streamed, and the interface was handled virtually for the first time, providing complete information on admissions, scholarships, and detailed introductions to departments programs. The department also cooperated with the school's measures by providing a pre-recorded video introduction to the department. Then in a live-stream, Prof. Chien-Ming Wu introduced the courses offered by the department and replied to questions from a student representative. These videos were shared on the Facebook of the Department of Atmospheric Sciences for students interested in atmospheric sciences.

今年持續受新冠肺炎疫情影響，本校於 2022 年 3 月 12 日及 13 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，更首度採用虛擬實境(VR)介面辦理，提供完整的招生、獎學金資訊及各學系、學位學程的詳盡介紹。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吳健銘老師進行線上直播介紹系所課程與 Q&A 並將影片分享在臉書系學會粉絲團供對大氣科學系有興趣的同學觀賞。

Commencement Ceremony

NTU's Commencement Ceremony was held on the morning of May 21st, but due to the impact of the epidemic this year, the hooding ceremony for the new graduates of our department was held on July 23rd. This time, we held the ceremony for the university and graduate school students at the same time, and the parents were arranged in another classroom to watch the live stream ceremony. The ceremony began with speeches by Prof. Chun-Chieh Wu, the Dean of the College of Science, Prof. Cheng-Ku Yu, the Department Chair, 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. 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 attend the graduation ceremony in person during the pandemic. A total of 28 bachelors, 14 masters and 4 doctors graduated from the department this year.

今年系上撥穗典禮因受疫情影響，延至 7 月 23 日下午於系館實體舉行，此次採大學部與研究所同時舉行，並將家長們安排於另一間教室，同步觀賞直播典禮現場。典禮首先由吳俊傑院長、游政谷系主任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，再由系主任位每個畢業生撥穗並提供畢業小禮物給每一位畢業生。在疫情期間，大家非常開心並珍惜能參與一場實體的畢業典禮。今年系上共有 28 名學士，14 名碩士及 4 名博士畢業。

Parents Day

Every September before the new semester starts, NTU holds a Parent-teacher meeting. NTU held an activity for this topic to help the freshmen know the campus well. Our Department Chair, Prof. Cheng-Ku Yu, also held a meeting for the freshman and their parents in the morning on August 28th, 2022, 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 月開學前學校會舉辦校級新生家長日，今年學校於 8 月 28 日至 9 月 1 日舉行開學典禮及新生入門書院活動，本系亦於 8 月 28 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，現場互動熱烈，增進新生及家長們與系上的交流。

Student Awards

- Tsubaki Hosokawa, a doctoral student of our department, received the Best Student Poster Award at the 19th Annual Meeting of the Asia Oceania Geosciences Society.
  博士生細川椿榮獲亞洲大洋洲地球科學學會第 19 屆年度會議最佳學生海報論文獎。

- Hsien-Jung Liao received the NSTC College Student Research Creation Award for the 2021 academic year.

- Jun-Jie Chang and Ching-Hung Shih received the Bachelor Paper Award for the 2021 academic year.
  張俊杰及施璟宏同學獲得 110 學年學士論文獎。

- Jui-Chia Hu received the NTU Altruism Award for the 2021 academic year.
  胡芮嘉同學獲得 110 學年利他獎。

2022 Undergraduate Summer Research Program Poster Presentation and Awards

To encourage undergraduate students to participate in research activities, the Summer Research Program was held in the department and culminated in a poster session at the end of the summer vacation. There were 10 teachers and 15 students (name list below), including sophomore and junior students for this activity. These students shared their results from their research and the best 5 poster winners were awarded as judged by their research advisors, 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 15 位二、三年級學生分別接受 10 位系上教師指導並進行研究，分組名單如下表。另本系於 9 月 2 日下午於大氣系系館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：龍威江、胡芮嘉、許耘華、謝杰儒及楊又丞。

分組	姓名	指導老師
A1	林宗勳	盧孟明
A2	胡芮嘉	黃彥婷
A3	許耘華	游政谷
A4	賴詩穎	林博雄
A5	姚博宸	郭鴻基
A6	王品羚	黃彥婷
A7	陳彥葦	洪惠敏
B1	張晉瑜	隋中興
B2	陳迦勒	郭鴻基
B3	李彥彤	盧孟明
B4	謝杰儒	吳健銘
B5	周子涵	梁禹喬
B6	楊又丞	陳維婷
B7	林軒誠	梁禹喬
B8	龍威江	游政谷

NTUAS Night

Our department student association held "NTUAS Night" on October 11th, 2022 in Yiren Hall of the First Student Activity Center. It was an unforgettable experience that showcased talents on stage in the midst of their university life. This activity was intensively prepared and practiced by students, and included drama performances, orchestra playing and singing, dance performances, etc. At the same time, the effect of the activity was to enhance the relationship between students in the department, and offered a unique opportunity for other departments to see the artistic side of our department.

本系系學會於 111 年 10 月 11 日假台大第一學生活動中心怡仁堂舉辦睽違四年的大氣之夜【大氣晚城】，在大學生涯中不可缺少在台上展現長才，本活動係透過密集籌備、練習，有戲劇演出、樂團彈唱、舞蹈表演等，同時藉此活動來增進系上同學彼此之間的感情，同時也是一個讓外系看見屬於大氣系最獨特的一面。

Department Chair's Meeting with Students

Department Chair, Prof. Cheng-Ku Yu, held the Chair meeting with graduate students and undergraduate students on December 6th and December 8th. In addition to introducing the course requirements to students, and encouraging students to plan their career earlier, Prof. Yu also awarded the Academic Excellence Awards and the Presidential Awards to students. The meeting minutes including the students' questions/suggestions and the department's responses will be posted on the department website.

系主任游政谷老師分別於 12 月 6 日及 12 月 8 日中午與研究所及大學部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 110 年第二學期書卷獎(吳柏慶、許米棋、張昱中、張筑怡、謝晉維、陶昱丞、邱曼甯及廖九令)及 111 學年度校長獎(陳峰及謝晉維)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。

NTU-KU Joint Workshop on Extreme Weather and Climate Impacts in East Asia

The NTU-KU Joint Workshop on Extreme Weather and Climate Impacts in East Asia was held by our department during November 21st to 23rd, 2022. Due to the impact of the epidemic, the workshop was conducted both in-person and online, and a total of about 90 attendees including teachers, students and researchers from National Taiwan University and Kyoto University participated the workshop (60 physical and 30 online). 3 professors and 7 Ph.D. and master students from Kyoto University and 1 researcher from the Institute of Meteorology of the Japan Meteorological Agency, and several professors and students from our department delivered oral presentations during the workshop. A total of 27 oral papers were presented (16 from National Taiwan University and 11 from Kyoto University).

There were four scientific topics of the workshop: Climate and Large-scale Circulations, Observations, Forecasting and Microphysics, Tropical Cyclones and Convective Systems, and Diurnal and Land Effects. There was one session chair for every session and the Q&As were opened for all participants after each presentation. The teachers and students from both institutions had a lively discussion and exchanged their ideas with each other.

This workshop promoted exchanges between Taiwan and Japan on extreme weather and climate impacts, and enhanced the knowledge exchange and cooperation between teachers and students from both institutions on all four topics. We would like to thank the teachers and students of our department for actively participating in this conference while under the impact of the epidemic, representing a successful continuation of international academic exchanges and ensuring future exchanges in the post-pandemic era.

　　理學院大氣科學系於 111 年 11 月 21 至 23 日舉辦台大與京都大學劇烈天氣與氣候衝擊研討會(NTU-KU Joint Workshop on Severe Weather and Climate Impacts in East Asia)，為因應新冠疫情的影響，本次研討會以實體與線上混合進行，共約 90 名台大與京都大學師生及研究人員參與 (60 名實體，30 名線上)。日本京都大學 3 位教授、7 位博、碩生、1 位日本氣象廳氣象研究所研究員及本系多名教授及其指導的研究生出席本次會議並發表論文。本次研討會總計 27 篇口頭報告論文(台大 16 篇，京大 11 篇)，研究內容精彩豐富，會中廣泛交流討論。

　　會議分為四個科學主題進行口頭報告，主題包含 Climate and Large-scale Circulations、Observations, Forecasting and Microphysics、Tropical Cyclones and Convective Systems 及 Diurnal and Land Effects，各主題安排一位主持人主持現場，每位報告結束後開放問題詢問，雙方師生討論熱烈並且交換各自的想法與建議。

　　本次研討會促進台日有關劇烈天氣與氣候衝擊之交流，並提升雙邊教師和研究生在天氣氣候方面的知識交流與合作。感謝本系師生在疫情衝擊下仍踴躍參與此會議並熱烈的討論及交換彼此意見，成功的達到後疫情時代國際間的學術交流，也讓此會議順利圓滿落幕。

VISITORS

- Dr. Shun-Nan Wu of the University of Oklahoma visited the department on January 4th, 2022, and delivered a seminar titled "Weather Forecast? Weather Intelligence!".

- Dr. Chih-Chieh Chen of NCAR visited the department on March 3rd, 2022, and delivered a seminar titled "Effects of organized mesoscale convection on the precipitation and MJO simulated by E3SMv1".

- Prof. Chen, Shu-Hua of UC Davis visited the department on March 31st, 2022, and delivered a seminar titled "Influence of dust on weather, large-scale circulations, and air-sea interactions over North Africa and the Atlantic Ocean".

- Dr. Clare Eayrs, Research Scientist of Center for Global Sea Level Change, NYU Abu Dhabi visited the department on April 19th, 2022, and delivered a seminar title "The perplexities of Antarctic sea ice behaviour during the satellite era".

- Dr. Hsu-Feng Teng, research scholar of the Department of Atmospheric Sciences, NTU delivered a seminar titled "Potential Impacts of Radio Occultation Data Assimilation on North Pacific High-Impact Weather Forecasts" on May 10th, 2022.

- Dr. Chao-Yuan Tang of the Department of Atmosphere Sciences, National Sun-Yat Sen University visited the department on May 17th, 2022, and delivered a seminar titled "Development of Coupled Modeling System for Arctic Sea Ice Simulation and Prediction".

- Prof. Pei-Chen Li of the Department of Health Care Management of National Taipei University visited the department on May 24th, 2022 and delivered a seminar titled "Epidemiological Research on Air Pollution".

- Prof. Angela K. Rowe of the Dept. of Atmospheric and Oceanic Sciences, University of Wisconsin at Madison visited the department on June 16th, 2022, and delivered a seminar title "Understanding extreme rainfall in mountainous terrain".

VISITORS

- Prof. Michael M. Bell of the Dept. of Atmospheric Science, Colorado State University visited the department on June 23rd, 2022 and delivered a seminar titled "Mechanisms for heavy rainfall production in tropical weather systems".

- Dr. Li-Wei Chao, PhD candidate of Texas A&M University visited the department on June 30th, 2022, and delivered a seminar titled "Impacts of the pattern effect on cloud feedback in satellite observations and climate models".

- Dr. Hsin Hsu, PhD candidate of George Mason University visited the department on July 11th, 2022, and delivered a seminar titled "Soil moisture-evaporation coupling shifts into new gears under increasing CO_2".

- Prof. Kristen Rasmussen of Colorado State University visited the department on July 12th, 2022, and delivered a seminar titled "The importance of topography in extreme rainfall events in weak and strong synoptic environments"

- Prof. Pao-Shin Chu of Department of Atmospheric Sciences, University of Hawaii-Manoa visited the department on July 15th, 2022, and delivered a seminar titled "Climate Variability and Tropical Cyclone Activity".

- Dr. Anthony C. Didlake, Associate Professor at Pennsylvania State University visited the department on July 19th, 2022, and delivered a seminar titled "Insights on the dynamics and microphysics of stratiform precipitation in tropical cyclones".

- Dr. I-Kuan Hu of Physical Science Laboratory, NOAA visited the department on September 20th, 2022, and delivered a seminar titled "Single-column root of general circulation model hierarchy".

- Prof. Shiuh-Shen Chien of Department of Geography and IPCS of National Taiwan University visited the department on September 27th, 2022, and delivered a seminar titled "因為空污看見風，透過風聞望到海－以大林蒲空氣運動為例談風在當代社會中的人文社會意義".

VISITORS

- Prof. Wen-Yi Sun of Purdue University visited the department on October 4th, 2022, and delivered a seminar titled "The revisit of parcel method and the CAPE".

- Lung, Shih-Chun, Research Fellow of Research Center Environmental Changes, ACADEMIA SINICA visited the department on October 11th, 2022, and delivered a seminar titled "環境健康的跨域合作：以PM2.5與熱傷害為例".

- Dr. Wen-Chau Lee, Senior Scientist, Manager of Remote Sensing Facility, NCAR/EOL/RSF, USA visited the department on October 18th, 2022, and delivered a seminar titled "Airborne Phased Array Radar (APAR): The Next Generation Airborne Polarimetric Doppler Weather Radar".

- Prof. Hui-Ting Lin of Institute of Oceanography, NTU visited the department on October 25th, 2022, and delivered a seminar titled "Biogeochemistry of submarine hydrothermal vents: the stinky Kueishantao vents".

- Chia-Chun Hsu, Research Fellow of Taiwan Forestry Research Institute visited the department on November 1st, 2022, and delivered a seminar titled "附生植物作為地區性森林氣候指標之研究--以棲蘭山區為例".

- Prof. Wei Weng of the Department of Geography, National Taiwan University visited the department on November 8th, 2022, and delivered a seminar titled "Aerial river management: strategic land planning for future water".

- Prof. Yi-Leng Chen of the Department of Atmospheric Sciences, University of Hawaii at Manoa visited the department on November 24th, 2022, and delivered a seminar titled "An Overview of Low-Level Jets (LLJs) and Their Roles in Heavy Rainfall over the Taiwan Area during the Early Summer Rainy Season".

- Dr. Everette Joseph, Director of NCAR, visited the department on November 24th, 2022, and delivered a seminar titled "Actionable Earth System Science for the Benefit of Society Working with our University Partners to Develop Solutions"

VISITORS

- Prof. Wei Kuo Tao of NASA, Department of Atmospheric Sciences visited the department on December 1st, 2022, and delivered a seminar titled "Relating Vertical Velocity and Cloud and Precipitation Properties: A Numerical Modeling Study".

- Mr. Meng-Han Ho of 派鑫有限公司 visited the department on December 6th, 2022, and delivered a seminar titled "氣候變遷零碳排是一個新鮮口號？還是商業型模式是否真有關連？?".

- Prof. Mark Thiemens, Chancellors Associates Chair and Distinguished Professor of the Dept. of Chemistry & Biochemistry Department, UCSD visited the department on December 8th, 2022, and delivered a seminar titled "The use of Naturally produced 35S to predict El Nino and La Nina events and solar cycles".

- Dr. Pei-Ning Feng of L' Université du Québec à Montréal (UQAM), Montréal, Québec visited the department on December 13th, 2022, and delivered a seminar titled "Impact of Adjusted and Non-Adjusted Surface Observations on the Cold Season Performance of the Canadian Precipitation Analysis".

- Prof. Johnny Luo of the Dept. of Earth & Atmospheric Sciences, City University of New York (CUNY), visited the department on December 20th, 2022, and delivered a seminar titled "On the use of trace gas measurements to quantify convective transport time scales and pathways".

- Dr. Kuang-Yu Chang of Lawrence Berkeley National Lab visited the department on December 29th, 2022, and delivered a seminar titled "Moving beyond model democracy: limitations and implications".

Hands-on Atmospheric Sciences: "Air Pollution Laboratory" Course

Wei-Chieh Huang, and Hui-Ming Hung

Atmospheric sciences include various research areas such as weather, climate, air quality, and issues related to our environment. These areas have a direct impact on our daily lives, for example, determining whether we need an umbrella when we go outside, if there will be a typhoon holiday tomorrow, or whether we should to wear a mask due to poor air quality. In addition to theoretical derivation and model analysis, field studies of atmospheric phenomena are also crucial. In this hands-on course, the students have the opportunity to design simple field campaigns to monitor the atmospheric phenomena they are interested in.

Air pollution is part of the environmental sciences that deals with atmospheric composition. According to research, people are frequently exposed to poor air quality and are at risk of cardiovascular disease. In recent years, smog and color level of air quality are commonly used terms to describe air pollution in news media. However, how much do we know about the composition of the air we inhale?

Since 2015, students have been learning and developing the Air Quality Box (AQB) system to explore the transport and evolution of air pollution. The current version of AQB is composed of low-cost sensors to monitor ambient gaseous pollutants (CO, NO, NO_2, O_3, SO_2, CO_2, and non-methane hydrocarbons), atmospheric aerosol particles (number size distribution for diameter in the range of 0.38-17 μm), and meteorological parameters (temperature, relative humidity, and pressure) as shown in Figure 1. With the design of the Internet of Things (IoT), the data can be transmitted to the cloud database in real-time and presented on the front-site webpage. With its lightweight design (~less than 1 kg), it can be applied to various applications. For example, AQB was attached to a hovering-type hexacopter unmanned aerial vehicle to monitor the vertical distribution of each pollutant in the urban area of Manaus, Brazil (Guimarães et al. 2020), and the impact of the local circulation on the Amazon River through the transport and dispersion of pollutants (Zhao et al. 2021) (Figure 2). Compared with the EPA stationary monitoring site, the AQB has a lower cost (less than 1/100th of a standard EPA site) and can be applied for observations at a higher spatial resolution. Currently, multi-point simultaneous observations are installed along a mountain valley in the central mountainous area of Taiwan (Figure 3). It can reveal the different diurnal patterns of pollutants due to the influence of valley wind transport and local emissions, as well as the trend of the particle number size distribution to reflect the fog formation and evolution. Because of its high portability and easy operation, AQB allows more people to have direct access to the observation experiment of air quality in a broad application.

In the fall of 2021, the "Air Pollution Laboratory" course using AQB as the core teaching system was offered in the Dept. of Atmospherics Sciences. Students learned the basics of the Raspberry Pi development board, principles of various micro-sensors, and simple IoT data transmission technologies. In the course, students were divided into three groups and tasked with proposing their own projects, making hypotheses, and conducting experiments to answer raised questions. The three projects focused on the impact of air pollution on aphid populations (insect group, Figure 4), air pollution caused by traffic (traffic group, Figure 5), and indoor air quality (indoor group, Figure 6). The insect group designed a closed system to monitor how the exhaust gas from automobiles affects aphid populations. They found that high levels of exhaust gas were beneficial to the growth and development of aphids with darker body color and a lower proportion of winged type. The observed characteristics indicate that automobile emissions could exacerbate the problem of aphids on plants. For the traffic group, they applied several AQB-GPS systems to monitor the chemical species concentrations on and off the NTU campus and to evaluate the total exposure to air pollution using different types of transportation (biking or walking inside the campus and riding a motorcycle outside the campus). The concentration of pollutants outside the campus was significantly higher than inside. They suggested that avoiding exposure to traffic emissions might reduce air pollution exposure related to cardiopulmonary diseases. The indoor group monitored the characteristics of air quality in a student study room and applied a simple box model to evaluate the trends of carbon dioxide and particulate matter. The concentration would change with the number of people, ventilation, and special events. Based on observations of indoor air quality amidst plant placements, they proposed constructive suggestions for improving indoor air quality through plant arrangements and ventilation strategies.

In every campaign, students learned to think creatively and analyze data in order to complete a small observing program in addition to gaining a basic understanding of instrumentation. This course provided an alternative form of training for students immersed in theoretical study and model analysis. It allowed them to experience the benefits of modern technology, such as using micro-sensors with simple coding to collect real-time data on air quality and meteorological parameters through interdisciplinary learning with IoT.

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動手玩大氣之二

黃維傑、洪惠敏

　　大氣科學是一門與生活相當貼近的應用科學，明天要不要帶傘出門？明天是否會放颱風假？空氣灰濛濛的要不要戴口罩？各式議題都是我們所關心的。除了理論的推導、模式的計算，對於生活中大氣現象的觀察及觀測也是不可或缺的，而探究實作課程使我們更能夠直接接觸這些議題，以實際的觀測對生活中遇到的現象去做思考。空氣汙染屬於大氣類別的環境科學議題，據研究顯示長時間暴露在空氣品質較差的環境中會影響到人體呼吸道、心血管疾病等健康問題。近年來我們時常在報章雜誌或新聞媒體中聽到紫爆、霧霾等等用來描述空氣污染的名詞，然而在驚聳的氛圍下，究竟我們對吸入的空氣成分有多少了解？

　　自 2015 年經由學生不斷學習發展，進而完成完整空氣品質盒子(Air Quality Box, AQB)來探討空氣汙染的傳送與演變過程。AQB 就像個簡易型的環保署測站，利用小型開發板(樹莓派, Raspberry Pi)操控各項微型感測器對周遭的環境做即時的量測。其中包括氣象參數—溫度、濕度、壓力；及環境中空氣物染物濃度—懸浮微粒、二氧化碳、一氧化碳、二氧化氮、一氧化氮、二氧化硫、臭氧、非甲烷有機性揮發氣體（圖一）。搭配物聯網的設計，可將資料即時傳輸至後端資料庫及呈現在前端網頁。由於它輕便的設計，可以適用於各類型的環境觀測，如在過去與國際合作的研究中將 AQB 搭載在多旋翼無人機上做大氣中的垂直量測，可看到在巴西瑪瑙斯市區中各項汙染物在乾濕季的垂直分布差異(Guimarães et al. 2020)、以及亞馬遜河上的局部環流對於汙染物傳送和擴散造成的影響 (Zhao et al. 2021) (圖二)。相比於固定式的環保署測站，AQB 的造價低(低於 1/100 環保署測站)可用於較密集的佈點觀測，目前在台灣中部山區沿著海拔高度進行多點同步觀測（圖三），可以看到因為山谷風傳送及當地排放的影響而造成汙染物濃度變化差異，以及起霧事件期間的霧滴數量濃度粒徑分布變化趨勢。AQB 因攜帶性非常高、且操作簡易讓更多人可直接接觸空氣品質的觀測實驗，其可應用的範圍甚廣。

　　在 110 學年度上學期大氣系所開設的「空氣污染實作」課程以 AQB 為核心教學，學生們學習樹莓派開發板基本功能、了解各個微型感測器的原理和運作方式、以及簡易的物聯網資料傳輸方法。在課程中，學生們分組對於生活中的議題做觀察及假設、並且設計實驗來做驗證。本學期的研究組別分做昆蟲組(圖四)、交通組(圖五)及室內組(圖六)：昆蟲組利用自製的封閉系統觀測汽機車廢氣對於蚜蟲族群的發展影響，發現暴露在高濃度機車廢氣中的蚜蟲族群成長較快速、體色較黑且有翅型的比例較低，多項特徵指出汽機車廢氣有利於蚜蟲族群的發展，在應用上可推測交通排放有可能加劇蚜蟲對於植物造成的蟲害危機；交通組將 AQB 加裝 GPS 定位系統，觀測台大校園內外不同交通方式對於空氣汙染數值的暴露總量差異，發現校園外的汙染物濃度遠高於校園內，在交界處有明顯的濃度遞減趨勢。在交通方式中避免暴露在交通污染排放高的車陣中，能有效減少空氣汙染引發的心肺疾病；室內組討論教室中的空氣品質特徵，利用簡易的 Box-model 描述教室內二氧化碳、懸浮微粒受到室內人數、通風性及特殊事件發生造成的濃度變化，另外實驗綠色植栽對於室內空氣品質的優化表現，在應用層面上可對教室內的植栽擺設及通風策略提出有建設性的建議。

　　學生們在空氣污染實作課程中，除了對於觀測工具的學習之外，透過親自實作，了解到大氣的觀測是一件不容易的工作，在理想的設計中時常會遇到突發狀況，學習如何靈機應變來完成一個小型觀測計劃。此課程提供給埋頭於理論學習及電腦計算分析的學生們另一層面的訓練，並了解現今科技的便利性讓自己可利用撰寫程式碼來控制微型感測器，進而得到環境的即時空氣品質數據及氣象參數，進而學習物聯網跨領域的另一連結。

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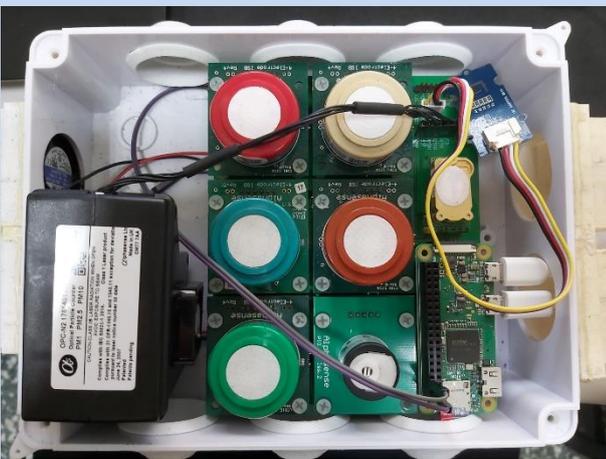
Figures:

Figure 1. The design of the air quality box (AQB) system

圖一：空氣品質盒子(AQB)內部設計，包含氣象參數以及各項空氣品質數值觀測

Figure 2. The AQB (the white box) was carried on a multirotor UAV to monitor the vertical distribution on the Amazon River (Zhao et al. 2021)

圖二：加載於多旋翼無人機上做大氣中的垂直量測（無人機下方的白色盒子是 AQB），照片中位置為亞馬遜河（Zhao et al. 2021）

Figure 3. AQB installed along with the mountain valley in the central mountainous area of Taiwan (AQB in Zhushan is shown in this figure)

圖三：台灣中部山區空氣品質觀測，照片中為其一架設位置—竹山鎮雲林國小

Figure 4. A simple system applied to study the influence of exhaust gas from automobiles on the development of aphid populations by the insect group

圖四：昆蟲組自製封閉系統觀測汽機車廢氣對於蚜蟲族群的發展影響（由謝佳暄及陳維庭同學提供）

Figure 5. AQB with GPS for mobile observation by the traffic group

圖五：交通組改裝 AQB 為後背型式，對台大校園內外進行移動觀測（由蔡杰森同學提供）

Figure 6. The optimization performance of green plants for indoor air quality by the indoor group

圖六：室內組實驗綠色植栽對於室內空氣品質的優化表現（由陳峰同學提供）

When Will Humanity Notice Its Influence on Atmospheric Rivers?
人類何時會察覺到暖化效應在大氣河上的影響？

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Quantifying the response of atmospheric rivers (ARs) to radiative forcing is challenging due to uncertainties caused by internal climate variability, differences in shared socioeconomic pathways (SSPs), and methods used in AR detection algorithms. In addition, the requirement of medium-to-high model resolution and ensemble sizes to explicitly simulate ARs and their statistics can be computationally expensive. In this study, we leverage the unique 50-km large ensembles generated by a Geophysical Fluid Dynamics Laboratory next-generation global climate model, Seamless system for Prediction and EArth system Research, to explore the warming response in ARs. Under both moderate and high emissions scenarios, increases in AR-day frequency emerge from the noise of internal variability by 2060. This signal is robust across different SSPs and time-independent detection criteria. We further examine an alternative approach proposed by Thompson et al. (2015), showing that unforced AR variability can be approximated by a first-order autoregressive process. The confidence intervals of the projected response can be analytically derived with a single ensemble member.

大氣河為地球中緯度最重要的傳現象之一，定量全球暖化對大氣河的影響卻極其困難，其中包含氣候震盪的隨機過程、暖化程度的不確定性以及大氣河定義上的差異...等，都會造成定量結果的不一。本研究利用美國海洋大氣總署地物流利實驗室的新一代氣候模型 SPEAR 來探討上述的不確定性。透過全球 50km 解析度的大系集數值模擬，我們發現全球暖化在大氣河上的訊號在 2060 年前就會統計上有意義的被偵測到，此訊號在不同的暖化情境以及不同的大氣河定義上都相當顯著。在這篇研究裡，我們也測試了 Thompson et al.(2015) 所提出的隨機過程模型，透過對照 SPEAR 的大系集模擬，發現氣候震盪的隨機過程對於大氣河的影響可以用布朗運動(AR-1 autocorrelation)來描述，同時只需單一系集，就能夠求出傳統上需要大系集模擬才能求出的暖化訊號的信心區間，大幅降低了氣候推估所需計算量。本研究在 2022 年發表在 JGR-Atmospheres 上。
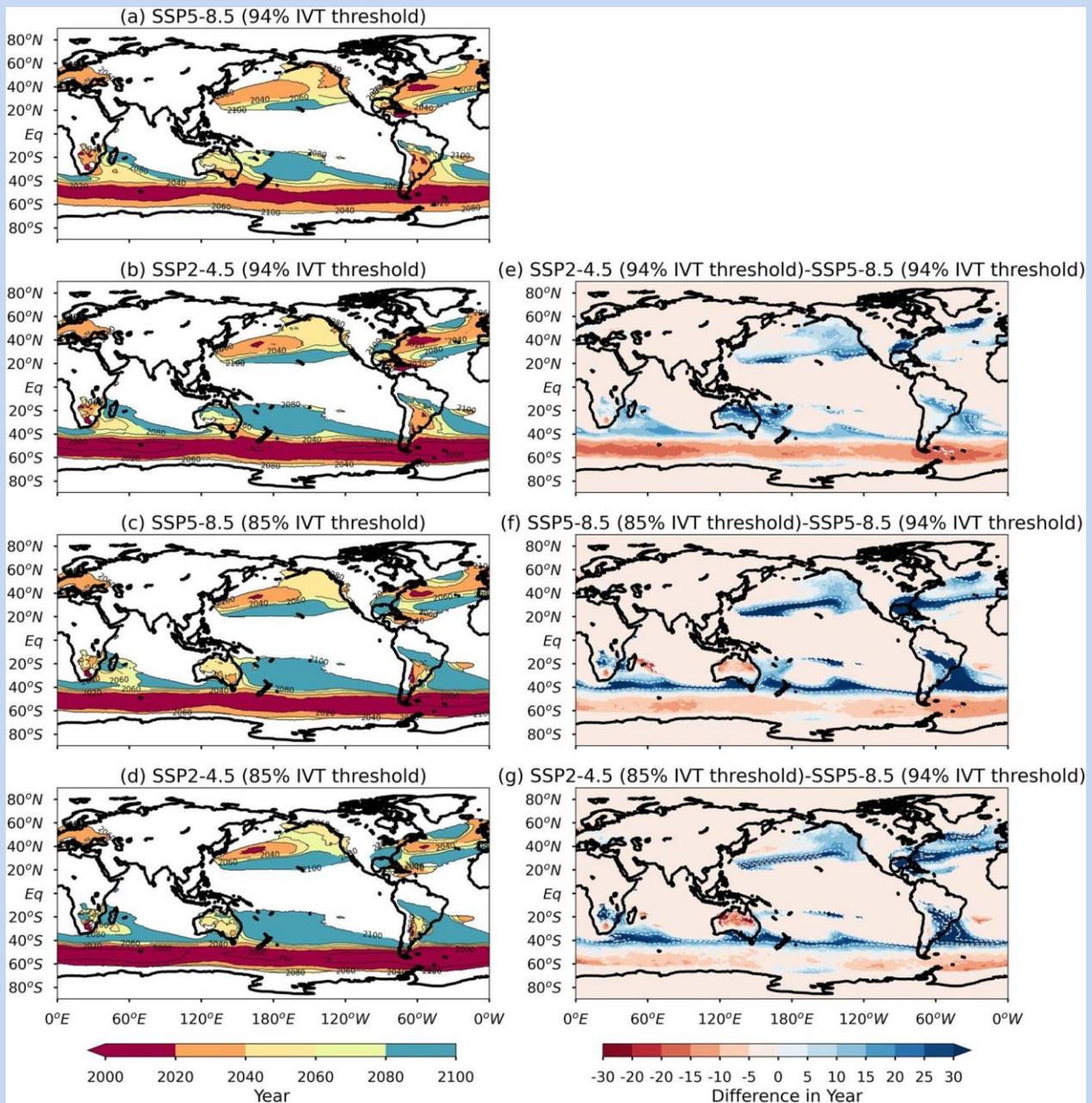
Fig. 1: Left: The time of signal emergence (year) over different warming scenarios and AR definitions. Right: the difference across combinations.

圖一：全球暖化在大氣河上產生顯著訊號的時間點(單位：年，圖左）各種暖化情境和大氣河定義下推估的時間差(單位：年，圖右）

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