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Newsletter

臺大大氣系所簡訊

Foreword

- Words from the Department Chair

Jen-Ping Chen

The Department of Atmospheric Sciences started as a small research center in the Department of Agronomy in 1946, one year after the end of WWII. In 1955 the undergraduate education program was established as the Division of Meteorology in the Department of Geography, and finally in 1972 it became an independent department. Over more than half a century, the Department of Atmospheric Sciences (NTU-AS) including its preceding entities has grown from only a handful of undergraduate students and faculties to a current size of 18 fulltime faculty members, around 150 undergraduates, over 60 graduate students and an almost equal number of staffs and researchers. As of now NTU-AS has graduated 970 undergraduates (including 87 from the Meteorology Section in the Geography Department) and 373 graduate students, 37 of them with Ph.D. degree. In addition, many people have visited or been associated with us in various capacity and became friends of the department. To all alumni and friends, we would like to keep in touch with you by presenting this newsletter to let you know what have been happening back here. We would also like to use this newsletter as a means to communicate with the atmospheric sciences community and other interested parties.

Quite a few changes in the department occurred recently. Professor Tai-Jen George Chen is in his third-year term as the Vice President of the university in charge of academic affairs. After a 10-year gap, we have recruited three new faculty members during the past four years. There are also several new adjunct appointments, including Professor Shaw-Chen Liu, Director of the Research Center for Environment Changes, Academia Sinica, and his fellow colleagues Professors Chia Chou and Shih-Chun Lung, as well as two visiting scholars: Professor Ming-Dah Chou who retired from Goddard Laboratory for Atmospheres, and most recently Professor Chih-Pei Chang who is visiting from the Naval Postgraduate School. Given in more details below are some academic activities and news items, including the three prestigious awards received by our faculty this year. A major content is research highlights, because of space limitation, in this issue we focus only in the areas of typhoon and air-sea interactions. Other areas such as monsoon climate and weather, aerosols, local circulations, and atmospheric chemistry will be highlighted in the subsequent issues.

This is the department's first newsletter, and we hope to continue to update you with new development in the department. Finally, I would like to express our special thanks to Professor C. P. Chang for his endeavor in helping with the birth of this newsletter, as well as those who have contributed greatly to the newsletter.

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Editor : Jen-Ping Chen (陳正平)
Advisory Editor : Chih-Pei Chang (張智北)
Editorial Assistant : Chia-Ling Tsai (蔡佳伶)
Yu-Ming Tsai (蔡禹明)

Address:
Department of Atmospheric Sciences
National Taiwan University
No. 1, Sec. 4, Roosevelt Road
Taipei 10617, Taiwan (R.O.C.)
TEL: 886-2-3366-3928
Website:
http://www.as.ntu.edu.tw/newsletter/
E-mail: newsletter@as.ntu.edu.tw

News

Three NTU-AS professors received major awards

Professor Hung-Chi Kuo was named one of three recipients of the 2007 National Chair Professor Award, the highest academic honor granted by the Ministry of Education of the Republic of China. Professor Kuo received the award because of his research accomplishments in geophysical fluid dynamics particularly on nonlinear typhoon vortex dynamics. Professor Kuo also received the honorary title of Distinguished Professor from National Taiwan University in 2006 when the honorary title system was first implemented at NTU.

Associate Professor I-I Lin was honored as one of the Ten Outstanding Young Women of the Republic of China for 2007 because of her research on remote sensing over the ocean, particularly on air-sea interactions. Previously, Professor Lin also received the Wu Ta-You Memorial Award from the National Science Council in 2005 and the American Geophysical Union's 2004 START Young Scientist Award.

Assistant Professor Yu-Heng Tseng received the Editor's Citation for Excellence in Refereeing-Water Resources Research in August 2007 from the American Geophysical Union. Eos, the weekly newspaper of the American Geophysical Union, also reported in a recent article with his photo that Professor Tseng has just been nominated for the AGU Best Reviewer's Award.

郭鴻基教授獲頒 2007 年教育部國家講座，此獎之「數學及自然科學」類科今年共有三位得獎者，是教育部所頒的最高學術榮譽。郭教授因其在地球物理流體力學，特別是在非線性颱風渦旋動力學的傑出研究而獲獎。郭教授在前(2006)年也獲頒臺灣大學特聘教授榮銜。

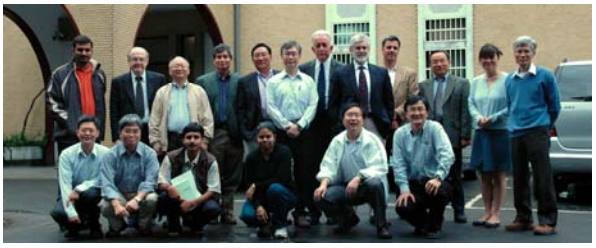
林依依副教授因其在海洋上關於海氣交互作用遙測之研究，而獲頒 2007 年中華民國十大傑出女青年獎。林教授在 2005 年曾獲得國科會吳大猷先生紀念獎，以及 2004 年美國地球物理聯合會 START 計畫的年輕科學家獎。

曾于恒助理教授於 2007 年 8 月獲得美國地球物理聯合會，水資源研究期刊主編之傑出審稿表揚。地球物理聯合會(AGU)週刊 EOS 最近並登出了一篇包含曾教授照片的新聞，報導其已被提名為 AGU 學術刊物最佳審查者獎候選人。

Meeting Highlights

University of Hawaii Visiting Workshop

In June 2007, Memorandum of Understanding (MOU) to promote education and research collaboration was signed between the department and the International Pacific Research Center (IPRC) and the Meteorological Department of the University of Hawaii (UH), USA. In November 2007, a team of 6 scientist, including J. McCreary (Head of the IPRC), T. Schroeder (Head of the Meteorological Department), J. Fei, T. Li, N. Schneider, and B. Wang visited NTU-AS. A 2-day workshop on climate and air-sea interaction was held (see attached photograph).



A group photo of the "University of Hawaii Visiting Workshop" during 2007 Nov. 5 to 6. From left to right, front: Y-H Tseng (NTU), W-S Kau (NTU), Anupam Hazra (NTU), Sahana Paul (NTU), Tim Li (UH), C-C Wu (NTU); back: Praveen Mallupattu (NTU), David Dietrich (Uni. of New Mexico), C-C Wu (NTU), H-C Kuo (NTU), Bin Wang (UH), J-P Chen (NTU, Department Chair), Tomas Schroeder (UH, Chair of Meteorological Department), Julian McCreary (UH, Director of IPRC/SOEST), Niklas Schneider (UH), F-F Jin (UH), I-I Lin (NTU), M-D Chou (NTU).

2007 年 11 月 5、6 日，臺大與夏威夷大學合作計畫與會人員合影。由左而右，前排：曾于恒(臺大)、柯文雄(臺大)、Anupam Hazra (臺大)、Sahana Paul(臺大)、Tim Li (夏威夷大學)、吳俊傑(臺大)；後排：Praveen Mallupattu(臺大), David Dietrich(新墨西哥大學)、吳清吉(臺大)、郭鴻基(臺大)、Bin Wang(夏威夷大學)、陳正平(臺大，系主任)、Tomas Schroeder(夏威夷大學，系主任)、Julian McCreary(夏威夷大學)、Niklas Schneider(夏威夷大學)、F-F Jin(夏威夷大學)、林依依(臺大)、周明達(臺大)。

International academic exchange activities

MOU for academic and research exchange were also signed between NTU-AS and institutes of two international Universities. The first one was signed this February with the Department of Earth and Atmospheric Sciences and the Atmospheric Sciences Research Center, University at Albany, State University of New York. Another one signed this September was with the Joint Center for High-impact Weather and Climate Research, Seoul National University. Exchange activities with these two universities are in progress.

International Conference on Mesoscale Meteorology and Typhoons in East Asia (ICMCS-6)

International Conference on Mesoscale Meteorology and Typhoons in East Asia (ICMCS-6) has been successfully held by the department at International Conference Hall of Central Weather Bureau on 6-9 November 2007. The major theme of the conference includes (1) quantitative precipitation estimation and forecasting, (2) mesoscale analysis and dynamics, and (3) typhoon studies. There are 120 abstracts submitted and more than 60 scientists from aboard, majorly from Japan, Korea, and United States presented their papers. The celebration banquet of 20th anniversary of TAMEX was also conducted at the same time. Next meeting will be held at Seoul in spring 2009.

National Taiwan University Department of Atmospheric Sciences is going to conduct a mesoscale field program at Kaohsiung-Pingtong area next May and June. The field program is called Southwest Monsoon Experiment (SoWMEX). It is a field program conducted jointly with National Center for Atmospheric Research Earth Observation Laboratory. The program directors are Prof. Ben Jong-Dao Jou of our department and Dr. Wen-Chau Lee of NCAR/EOL. The field program is a joint effort of Central Weather Bureau, National Central University and many other institutes from Taiwan and USA. NCAR SPOL (S-band polarimetric radar system) will be deployed at mouth of Kao-Ping Xie. Dropsonde and ship sounding will also be conducted during the field observational period. The data collected will be helpful to understand the heavy rain episodes caused by southwesterly flows during the Asian summer monsoon season. With high resolution polarimetric radar data, the microphysical characteristics of the heavy rain systems can be explored first time in the Asia region.

第六屆 東亞地區中尺度氣象和颱風 國際研討會(ICMCS-6)

第六屆東亞地區中尺度氣象和颱風國際研討會(ICMCS-VI)，順利地於 2007 年 11 月 6-9 日在臺灣中央氣象局國際會議廳舉行，並圓滿完成。研討會的主要議題包括(1)定量降水估計和預報，(2)中尺度分析和動力過程，以及(3)颱風研究。有 120 篇摘要投稿於此研討會中，超過 60 位的國外專家學者參與，主要來自日本、韓國、美國等，並發表他們的論文。研討會期間，同時也舉辦了 TAMEX 20 週年紀念慶祝晚宴。第七屆 ICMCS 將於 2009 年春天在韓國首爾舉行。

國立臺灣大學大氣科學系將於明年5月和6月在高雄屏東地區進行中尺度野外實驗。此實驗稱為西南季風實驗 (SoWMEX)，將與美國國家大氣研究中心(NCAR)共同進行。實驗計畫主持人為本校大氣科學系周仲島教授，NCAR 地球觀測實驗室李文兆博士為美方代表。執行實驗的機構主要為本校大氣科學系、中央氣象局、中央大學，以及 NCAR，另外將有許多國內外研究機構與學校單位共同參與。在野外觀測實驗期間，NCAR 的 SPOL (S 波段雙偏振雷達系統)將放置在高屏溪河口，並將增加機載投落送探空和船舶探空的密集觀測。收集的資料將有助於瞭解亞洲夏季風，西南氣流造成的豪大雨過程，而高解析度雙偏振雷達在亞洲地區有首次機會探索豪大雨天氣系統的微物理特徵。

A group photo of the "International Conference on Mesoscale Meteorology and Typhoons in East Asia (ICMCS-6)."

第六屆東亞地區中尺度氣象和颱風國際研討會(ICMCS-6)開幕式合影。

Pacific Science Association Symposium on Global Change, Asian Monsoon and Extreme Weather and Climate, was held at National Taiwan University on 11-12 June, 2007

The Pacific Sciences Association (PSA) held its 21st Congress (PSC21), a once-every-four-years events attended by leaders of the academic and research communities around the Asia-Pacific, on June 17-22 in Okinawa Japan. Prior to the Congress the PSA Meteorology Committee held a one-and-a-half-day pre-congress symposium on Global Change, Asian Monsoon, and Extreme Weather and Climate on 11-12 June 2007 in Taipei. One of the main objectives was to promote discussions on the scientific goals and international cooperation of observational weather and climate experiments that are proposed in the western Pacific – South China Sea region. The Symposium was hosted by NTU who cosponsored the meeting with the Earth Science Promotion Center of National Science Council, Central Weather Bureau, National Science and Technology Center for Disaster Reduction, National Central University, Chinese Culture University, and Academia Sinica. Several NTU faculty and students joined the local organization team led by Dr. Mong-Ming Lu of CWB (a NTU ATM alumni) to run the meeting and visitor programs.

The symposium consisted of 28 invited presentations organized into four sections: tropical cyclones, climate variation and tropical cyclones, monsoon and climate, and programs and projects. The opening speeches were delivered by Dr. Ching-Yen Tsay, Chair of PSA Committee on Meteorology and Atmospheric Sciences, and Dr. Chang-Hung Chou, Academician of Academia Sinica (National Academy of Sciences) and the Director of the Research Center for Biodiversity, China Medical University.

The speakers were from Germany, Hong Kong, Indonesia, Japan, Korea, Malaysia, USA and Viet Nam, in addition to Taiwan. The scientific goals of the major research programs and observational experiments were discussed by major program or project leaders, including Professor Bin Wang (University of Hawaii) for the CLIVAR Asian-Australian Monsoon Panel, Dr. Simon Chang (U.S. Naval Research Laboratory) for Tropical Cyclone Structure 2008 (TCS08), Dr. Dave Parsons (NCAR) for THORPEX Pacific Asia Regional Campaign (T-PARC), and Jun Matsumoto (Tokyo Metropolitan University) for the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI) and Asian Monsoon Year 2008 (AMY08). Two major observational experiments around Taiwan were presented by NTU faculty members: Professor Chun-Chieh Wu discussed DORSTAR for studying tropical cyclones; and Professor Joug-Dao Ben Jou discussed SoWMEX-TiMREX for studying heavy rainfall during summer monsoon. NTU Professor Huang-Hsiung Hsu also gave a talk on the role of tropical cyclones in climate modeling. Other Taiwan speakers include Dr. Mong-Ming Lu (CWB), Dr. Chia Chou (Academia Sinica), Professor Jia-Yuh Yu (CCU), Professor Chung-Hsing Shui (NCU), Professor Cheng-Ta Chen (NTNU), and Professor Chih-Hua Tsou (NTNU).

In addition to the scientific presentations, Dr. Steve Zebiak, Director of International Research Institute for Climate and Society, gave a special talk discussing the challenges of managing climate related risks and opportunities

The organizing committee of the Taipei symposium, including NTU Professors Huang-Hsiung Hsu, Chun-Chieh Wu, Ben Jou and C.P. Chang (Visiting from Naval Postgraduate School) and colleagues from other Taiwan institutions, also joined the PSA Committee on Global Change (led by Professor Congbin Fu of the Chinese Academy of Science) and Japanese host Professor Tetsuzo Yasunari of Nagoya University to organize the PSC21 Session on Global change, Asian monsoon, and Extreme Weather and Climate in Okinawa. That Session consists of 30 speakers from various countries in Asia, U.S. and Europe.

太平洋科學協會
「全球變遷、亞洲季風、極端天氣與氣候研討會」在本校舉行

太平洋科學協會(PSA)第二十一屆四年一次的大會(PSC21)於 2007 年 6 月在琉球舉行。PSA 氣象委員會於會前一週，邀請國際多位有影響力的科學家，在 2007 年 6 月 11-12 日在臺大舉辦會前國際研討會，主題是「全球變遷、亞洲季風、極端天氣、與氣候」。主辦單位計有國科會地球科學研究推動中心、交通部中央氣象局、臺灣大學、國家災害防救科技中心、中央大學、文化大學、以及中央研究院。研討會的主要目的是要推動預定明年在亞洲與太平洋區域舉行的多項大型國際氣象觀測實驗與研究計畫，促進相關討論與增進了解。本系好幾位教授是委員會成員，除了組織和參與會議之外，還有幾位師生參加了中央氣象局盧孟明博士(本系系友)領導的籌備和支援工作。

研討會的主體是 28 篇邀請報告，分為颱風、氣候變異與颱風、季風與氣候、觀測及研究計畫四個主題。開幕典禮首先由太平洋科學協會氣象與大氣科學委員會主席蔡清彥教授致歡迎詞，接著由中央研究院院士周昌弘校長演講。周校長特別強調環境保育對減輕伴隨極端天氣與氣候事件的災害之重要性。

研討會演講者除本國專家以外其餘來自德國、香港、印尼、日本、韓國、馬來西亞、美國、及越南等地。多位國際大型觀測與研究計畫的主要負責人深入說明了所負責的計畫內容，圓滿達成研討會預定目標，其中包括美國夏威夷大學王斌介紹了 CLIVAR 的亞澳季風研究、美國海軍研究所張偉正介紹 TCS08 實驗、美國國家大氣科學研究中心(NCAR)的 Dave Parsons 介紹 T-PARC 實驗、以及日本東京都會大學 Jun Matsumoto 介紹 MAHASRI 實驗與 AMY08 實驗群。美國國家航空及太空總署噴射推進實驗室科學家 Tim Liu 介紹衛星散射計(scatterometer)資料的重要貢獻，臺灣的兩項重要颱風實驗(追風計畫)與西南氣流實驗(SoWMEX-TiMREX)分別由本系吳俊傑與周仲島教授介紹。另外，美國氣候與社會國際研究院 Steve Zebiak 則以亞洲為例介紹氣候風險與機會的管理。其他應邀報告的臺灣學者包括中央氣象局盧孟明博士、中研院周佳博士、文化大學余嘉裕教授、中央大學隋中興教授及師大陳正達教授和鄒治華教授等人，其中多數為本系系友。

這次研討會成功地聚集了研究全球變遷、亞洲季風、極端天氣與氣候事件等方面不同領域的專家一同對話，激發了關於氣候、颱風和中尺度天氣研究的熱烈討論。最後，還值得一提的是本研討會籌備委員會包括許晃雄、吳俊傑、周仲島與張智北教授成功地和 PSA 全球變遷委員會主席中國科學院符淙斌院士，及日籍主席名古屋大學 Tetsuzo Yasunari 教授合作，在琉球舉辦的 PSC21 大會組織了一天半的「全球變遷、季風極端天氣與氣候」研討會，共計有 30 篇論文由來自不同國家的作者發表。這部分的研討於六月十六、十七日在琉球舉行完畢。

Pacific Science Association and NTU-AS

Founded in 1920, the Pacific Science Association (PSA) is a regional, non-governmental, scholarly organization that seeks to advance science and technology in support of sustainable development in the Asia-Pacific.

- 1991: Professor Ching-Yen Tsay, then Department Chairman, was appointed to become Chairman of the PSA Scientific Committee for Meteorology and Atmospheric Sciences.
- 1998: The 9th Pacific Science Inter-Congress was hosted by Academia Sinica in Taipei. Professor Tsay organized the Symposium of Atmospheric and Marine Sciences that was attended by over sixty domestic and overseas scientists.
- 2002: The WMO 5th International Workshop on Tropical Cyclones at Carins, Australia. Professor Chun-Chieh Wu and Dr. Tian-Chiang Yeh (Central Weather Bureau) representing PSA to attend.
- 2006: The WMO Winter MONEX Quarter Century Symposium at Kuala Lumpur, Malaysia. Five Taiwan scientists represented PSA attended, including the two NTU Professors LinHo and Huang-Hsiung Hsu who presented invited papers. Other representatives were Professor Chung-Hsing Sui (National Central University), Dr. Mong-Ming Lu (CWB) and Ms. Alice Yun-Lan Chen (CWB).
- 2006: WMO 6th International Workshop on Tropical Cyclones at San Jose, Costa Rica. Professor Chun-Chieh Wu represented PSA and discussed typhoon research in Taiwan.
- 2007: The 21st Pacific Science Congress was held in Okinawa, Japan. The PSA Committees on Meteorology and on Global Change jointly organized the Symposium on Global Change, Asian monsoon, and Extreme Weather and Climate. Prior to the Congress the Meteorology Committee also organized a pre-congress symposium of the same topic at NTU on June 11-12.

A group photo of the "Mini-workshop on the planning of the collaborating programs in T-PARC" organized by C-C Wu, during the PSA workshop at NTU on June 12, 2007.

From left to right, front: M-D Chou (NTU), Dave Parsons (NCAR), Simon Chang (NRL), Melinda Peng (NRL); back: H-H Hsu (NTU), M. Yamaguchi (JMA), P-H Lin (NTU), T. Nakazawa (MRI/JMA), Dong-In Lee (PNU), M-D Cheng (CWB), C-C WU (NTU).

2007 年 6 月 12 日，太平洋科學協會研討會期間吳俊傑教授所主持於臺大大氣系舉行的「T-PARC 研究合作規劃研討會」與會人員合影。由左而右，前排：周明達(臺大)、Dave Parsons (NCAR)、張偉正(美國海軍研究所)、彭順台 (美國海軍研究所)；後排：M. Yamaguchi (日本氣象廳)、許晃雄(臺大)、林博雄(臺大)、T. Nakazawa (日本氣象研究所)，Dong-In Lee (韓國釜山大學)、鄭明典(中央氣象局)、吳俊傑(臺大)。

Research Highlights

Typhoon rainfall over Taiwan and landfall process

The continuous torrential rain associated with a landfalling typhoon often causes serious damages in Taiwan due to floods, landslides and debris flows. This project focused on the research and development of quantitative rainfall forecast schemes as a collaborative effort between NTU, National Center for Disaster Reduction, and the Central Weather Bureau. The project is led by Professor Cheng-Shang Lee, a graduate of the department in 1976 who received his Ph.D from Colorado State University in 1986 and returned to join the department faculty same year. He and his colleagues used hourly rainfall amount at 371 stations during 1989-2001 to develop a climatology model for typhoon rainfall, which considered the topographical lifting and the variations of rain rate with typhoon radius (Lee et al. 2006a). The model provides estimated hourly rainfall at any station and river basin for a given typhoon center location based on the CWB forecasted typhoon track. The cumulative rainfall along the forecasted typhoon track was also available. The results showed that the R-square value between the model estimated and the observed cumulative rainfall during typhoon periods for the Dan-Shui River Basin in northern Taiwan and the Kao-Ping River basin in southern Taiwan reached 0.70 and 0.81, respectively. The R-square values decreased slightly to 0.69 and 0.73 if individual stations were considered. For example, the model could give reasonable cumulative rainfall amount at Dan-Shui before Nakri (2002) made landfall on Taiwan, but overestimated the rainfall after Nakri made landfall and weakened with significant reduction in convection. Currently, this model is used operationally in the Central Emergency Response Center during typhoon warning periods to provide rainfall estimates in order to issue debris flow and flooding warning. Efforts are continuing in an attempt to incorporate typhoon characteristics and satellite rainfall climatology to improve this model.

One of the more unusual landfalling cases is Typhoon Mindulle of 2004, which made landfall on the east coast of Taiwan on 1 July 2004 and exited Taiwan from the north coast 13 hours later. Severe rainfall occurred over central-southwestern Taiwan on 2 July. While Mindulle's main circulation was over land, a secondary low formed over the Taiwan Strait. However, the secondary low, after it developed significantly, did not replace the original center as was observed in many other storms. Instead, it moved inland and dissipated after the original center re-developed near the north coast of Taiwan. This unusual behavior has caused considerable difficulty in tracking the typhoon during Mindulle's influence over Taiwan. Professor Lee and his colleagues just completed a modeling study to analyze the evolution of the secondary low, the re-development of the primary center and the processes leading to the severe rainfall.

Another area of Professor Lee's research is on the formation of typhoons in the South China Sea during the East Asian summer monsoon rainfall system of Meiyu, when interaction of the Meiyu frontal system and tropical cyclogenesis led to unusual development processes (Lee et al. 2006b). They are currently extending the research to the winter periods, when the winter monsoon affects the South China Sea typhoon formations.

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李清勝教授於 1976 年自本系大學部畢業，於 1986 年獲美國科羅拉多州立大學博士學位，後即返回母系服務，於 1991 年升任正教授。他的研究興趣包括：發展可實際運用的颱風降雨預報的氣候模式，以提供颱風期間各測站及各流域之逐時雨量估計；針對特殊侵台颱風進行模擬和分析，以瞭解造成特殊路徑和持續性豪雨的機制；分析伴隨梅雨鋒面形成之颱風的重要機制，以及分析冬季東北季風影響下於南海形成颱風之過程。

Tropical Cyclone Dynamics

The dynamics of tropical cyclones, including the formation, intensification and structure change, is important both as a theoretical problem and in the efforts to improve forecasting. This project is led by Professor Hung-Chi Kuo, who graduated from NTUAS in 1979 and received his Ph.D. from Colorado State University in 1987. Before returning to Taiwan in 1990, he was a research scientist at the Naval Research Laboratory in Monterey, California where he was one of the two original leaders in the development of the US Navy's operational limited area model (COAMPS).

One of the interesting problems in typhoon formation is that in some years typhoons form successively every one week to ten days in the confluence zone near the eastern end of the western North Pacific monsoon trough. Through barotropic modeling Professor Kuo and his colleagues proposed a nonlinear theory that tropical vortices may develop through wave accumulation and/or scale contraction in energy dispersion (Kuo et al 2001a). The study suggests the importance of the background confluent flow, scale contraction of short Rossby waves as well as Rossby wave energy dispersion from typhoons, and nonlinear dynamics. Another important formation problem emerged in late December 2001 when Typhoon Vamei developed near Singapore, only 1.5 degrees north of the equator. Professor Kuo joined Professor C.P. Chang of the Naval Postgraduate School and Professor Ching-Hwang Liu of the Chinese Culture University to assess the roles and probabilities of winter monsoon circulations in this rare equatorial cyclogenesis (Chang et al 2003).

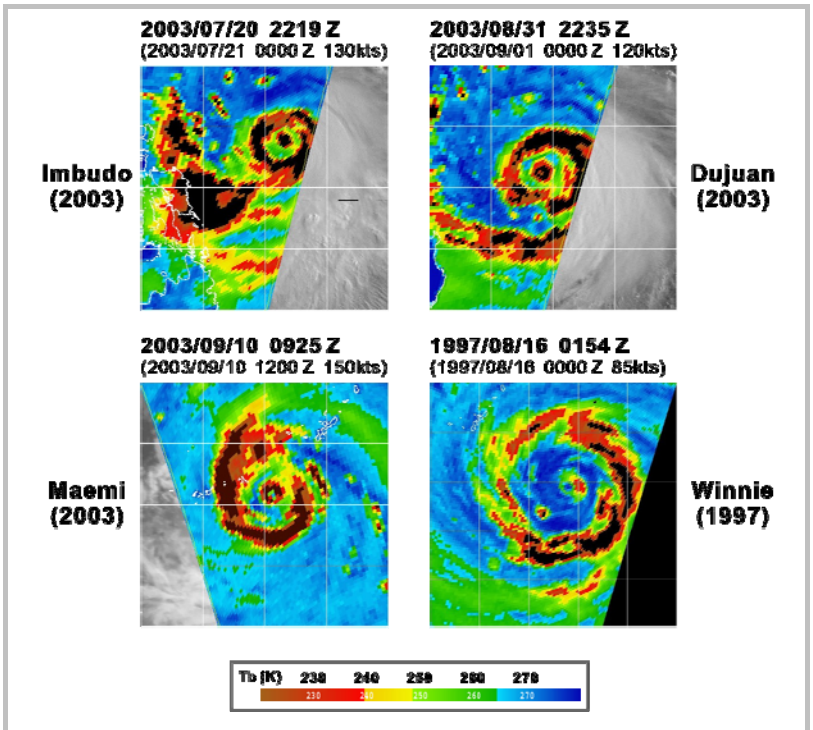

Fig. 1 Concentric eyewalls of various size as revealed by microwave satellite imaginaries. (image courtesy of Naval Research Laboratory, Monterey, California)

Professor Kuo and his colleagues and students also studied the impact of island topography that induces a vortex stretching effect on the typhoon-like vortex movement. They proposed a square root law of the vortex drifting velocity and the "island trapping" mode of the vortex, in which nonlinear dynamics plays a crucial role in maintaining the vortex against the beta effect and the topography-induced energy dispersion (Kuo et al. 2001b). The theory can find an application in typhoon approaching Taiwan Island. It explains the fact that the typhoons sometimes drift southward before the landfall on the east coast of Taiwan. These results have oceanographic application also. The coherency of the strong vortices in the ocean allows thermal and salinity anomalies to be transported far downstream.

The appearance of concentric eyewalls in many strong typhoons has motivated many researchers to study the process leading to their formation. Understanding of this process is also important for prediction of intensity changes. Previous studies are either based on symmetric models, or based on asymmetric models without considering the asymmetric dynamics processes that are intrinsic to the tropical cyclone vortices. Motivated by radar observations of large asymmetric convection field outside of the core of Typhoon Lekima that hit Taiwan in 2001, Professor Kuo and his colleagues extended Dritschel and Waugh's binary vortex interaction model and developed a theory to explain how a symmetric concentric eyewall can be organized from an asymmetric convection field. They showed that the core vortex of a tropical cyclone induces a differential rotation across the asymmetric large and weak vorticity field that is induced by the outer radius moist convection to strain out the latter into a vorticity band surrounding the former. Under proper conditions the strong inner vortex can cause the wind at the inner edge to be stronger than the outer edge, which allows the vorticity band and therefore the concentric structure to be sustained. Moreover, the inner vortex must possess high vorticity not only against any deformation induced by the outer vortices but also to maintain a smaller enstrophy cascade and to resist the merger process into a monopole.

(Kuo et al. 2004). This work was further extended to emphasize the interactions among the typhoon vortex skirted structure, background turbulence, and the size of the concentric eyewalls. The results highlight upscale energy cascade in a strong rotating environment and the pivotal role of moat and the strength of the core vortex in the turbulent environment that lead to the formation of the concentric structure (Kuo et al. 2006).

Presently Professor Kuo and his colleagues and students are analyzing the entire sample of microwave satellite data for the past decade, in order to study the general characteristics of all western North Pacific typhoons with a concentric structure.

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郭鴻基教授於 1979 年畢業於本系，於 1987 年取得美國科羅拉多州立大學博士學位；在 1990 年回國服務以前，於美國海軍研究所擔任研究員，並成為美國海軍區域作業模式發展計畫的二位主持人之一；1993 年升任正教授。他並曾先後擔任美國 UCLA 及普渡大學動力氣象學客座教授，目前也在臺大生命科學系和數學系開授多門應用數學課程。主要研究課題包括高效率計算數學、熱帶氣旋生成、強化和結構改變的動力過程，島嶼地形所造成的渦旋拉伸與對渦旋路徑的影響、雙眼牆結構特性與形成機制。

DOTSTAR (Dropsonde Observation for Typhoon Surveillance near the TAiwan Region) and targeted observation research

DOTSTAR is a major observational program that marks the beginning of a new era in which aircraft surveillance of typhoons is returning to the western North Pacific after a two-decade absence. Built upon work pioneered at U.S. NOAA's Hurricane Research Division (HRD), DOTSTAR uses airborne sensors, the dropwindsondes, that are released from a jet aircraft flying above 42,000 feet in the environment of a tropical cyclone. These sensors gather temperature, humidity, pressure, and wind velocity information as they fall towards the surface.

The project is directed by Professor Chun-Chieh Wu. He and Professor Po-Hsiung Lin of the Department launched DOTSTAR in 2003 with the sponsorship of the Central Weather Bureau (CWB) and the National Science Council (NSC). The project attracted strong international interest. Currently, international collaborating scientists include those from the HRD and NOAA's National Centers for Environmental Prediction (NCEP), the U.S. Navy's Naval Research Laboratory, and the Meteorological Research Institute of Japan Meteorological Agency.

Data from the surveillance flights are transmitted near real-time to CWB in Taipei, as well as to the data centers at NCEP in Washington, D.C., U.S. Navy's Fleet Numerical Weather Central (FNMOC) in Monterey, California, UK Meteorological Department (UKMET) in Reading, and JMA in Tokyo. The data are immediately assimilated into the numerical models of CWB, NCEP (AVN/GFDL), FNMOC (NOGAPS/COAMPS/GFDN), UKMET, and JMA. The DOTSTAR data are expected to improve the accuracy of tropical cyclone analysis and track forecasts. The data are also valuable in the assessment of data impact studies in numerical models, the evaluation of strategies for adaptive/targeted observations, the validation/calibration of remote-sensing data, and the understandings of the TC dynamics especially about the boundary layer (e.g., Wu et al. 2005, 2007).

Up to October 2007 DOTSTAR has conducted 28 surveillance flight missions for 24 typhoons, with 147 flight hours and 447 dropsondes released. A paper by Professor Wu and his U.S. and Japanese colleagues will report in a forthcoming issue of Weather and Forecasting an average 20% improvement for the 12-72h track forecasts for the NCEP-GFS, FNMOC-NOGAPS, JMA-GSM and their ensembles, as well as the WRF model.

Several techniques have been used to help design the flight path for the targeted observations in DOTSTAR, including: (1) the area with the largest forecast deep-layer-mean wind bred vectors from the NCEP Global Ensemble Forecasting System at the observation time, (2) the Ensemble Transform Kalman Filter, which predicts the reduction in forecast error

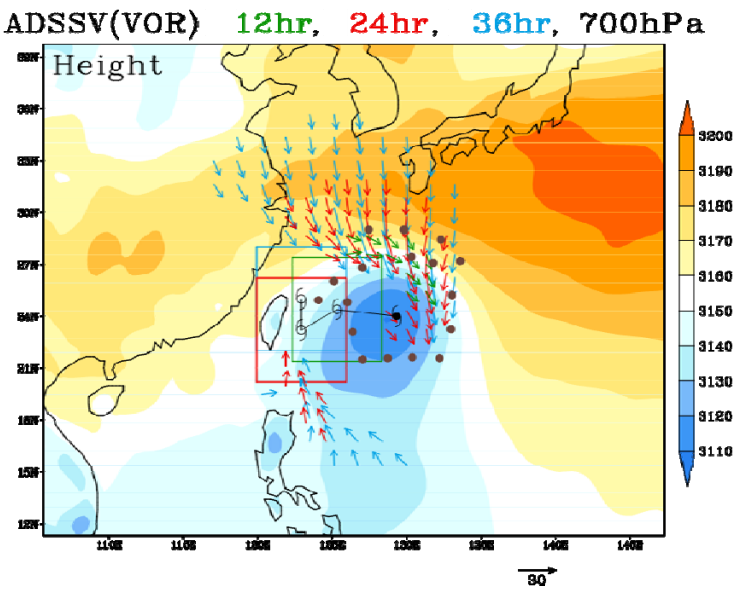

Fig. 2 ADSSV with respect to the vorticity field at 700 hPa at 12 (in green), 24 (in red) and 36 h (in blue) as the verifying time, superposed with the geopotential height field (magnitude scaled by the color bar to the right, unit: m) at 700 hPa and the deployed locations of the dropsondes in DOTSTAR (brown dots) for Typhoon Meari at 1200 UTC 25 September, 2004. The scale of the ADSSV vector is indicated as the arrow to the lower right (unit: m). The three square boxes represent the verifying areas at three different verifying times. (from Wu et al. 2007)

variance for all feasible deployments of targeted observations, and (3) the NOGAPS singular vectors that identify sensitive regions. Recently the DOTSTAR team has developed a new method to identify the sensitive area for the targeted observations of tropical cyclones based on the adjoint model (Wu et al. 2007). By appropriately defining the response functions to represent typhoon's steering flow at the verifying time, a new parameter, the Adjoint-Derived Sensitivity Steering Vector (ADSSV), is designed to demonstrate the sensitivity locations at the observing time. The ADSSV's, which have also been used in the hurricane surveillance program at HRD in the Atlantic in 2005 (Etherton et al. 2006), are being implemented and examined in DOTSTAR. An inter-comparison study is being conducted to examine the common feature and difference among all the different targeting techniques. Professor Wu gave a review talk on "Targeted Observation and Data Assimilation for Improving Tropical Cyclone Track Prediction" at the Sixth International Workshop on Tropical Cyclones (IWTC-VI, 2006, San Jose, Costa Rica) organized by the World Meteorological Organization (Wu 2006). Meanwhile, Professor Wu and students are developing better methods to combine the dropwindsonde data with the bogused vortex in numerical models.

In 2008, DOTSTAR will be a collaborating component in the international THORPEX-PARC initiative of WMO, especially with respect to the joint surveillance observation of the Japanese program Typhoon Hunting 2008 (TH08) led by Dr. T. Nakazawa of MRI. It is hoped that DOTSTAR will continue to shed light on typhoon dynamics, improve the understanding and predictability of typhoon track through the targeted observations, and make a significant contribution to the study of typhoons in the northwestern Pacific and East Asia region.

Professor Wu graduated from the department in 1986. He received his Ph.D. from MIT in 1993 and conducted postdoctoral research at GFDL before returning to join the NTUAS faculty in 1994. More information on DOTSTAR is available at: http://typhoon.as.ntu.edu.tw/DOTSTAR/English/home2_english.htm.

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吳俊傑教授於 1986 年自本系大學部畢業，1993 獲麻省理工學院博士學位，曾在普林斯頓大學作研究，於 1994 年返系任職，2000 年升任正教授。研究主題包括以機載投落送對颱風進行觀測，並將資料即時同化到各全球作業模式中，以協助預測及分析颱風路徑及結構，校驗衛星資料與分析颱風海洋邊界層特性；此外也進行各種颱風觀測策略理論比較及資料同化研究，尋找影響颱風路徑的敏感區域，提供作為評估策略性觀測的方法；他也使用理想的颱風海洋耦合模式探討颱風與海洋的相互作用，詮釋海洋表面熱力結構對颱風強度的影響機制。

The Effect of the Ocean Eddy on Tropical Cyclone Intensity

The rapid intensification of Hurricane Katrina followed by devastation to the Gulf States of the U.S. provides a case in point to highlight the critical role played by the upper oceanic thermal structure (such as the ocean eddy or Loop Current) in affecting the development of tropical cyclones. Professors I-I Lin and Chun-Chieh Wu and colleagues and student have studied this issue for several years.

One case they analyzed was Super Typhoon Maemi, the most intense tropical cyclone in 2003, to show that warm ocean eddies can play a significant role in typhoon's intensification in the Northwest Pacific Ocean (Lin et al. 2005). Maemi passed directly over a prominent (700 km x 500 km) warm ocean eddy located in the 22°N eddy-rich zone in the Northwest Pacific. During the 36 hours of the eddy encounter, Maemi's intensity shot up from 41 ms^{-1} to a peak of 77 ms^{-1}. They used the Coupled Hurricane Intensity Prediction System and satellite microwave sea surface temperature observations to show that the warm eddies acted as an effective insulator between typhoons and the deeper ocean cold water. The typhoon's self-induced sea surface temperature cooling was suppressed owing to the presence of the thicker upper-ocean mixed layer in the warm eddy, which prevented the deeper cold water from being entrained into the upper-ocean mixed layer. Using the Coupled Hurricane Intensity Prediction System, they showed that the incorporation of the eddy information yielded an improvement in the simulation of Maemi's intensification, with its peak intensity increased by one category and maintained at category-5 strength for the entire 36 h period. Given the abundance of ocean eddies in the western North Pacific, their results highlighted the importance of the interaction with ocean eddies in the understanding and prediction of tropical cyclone intensity changes.

Professors Wu and Lin also investigated the impact of the ocean eddy on tropical cyclone intensity using an idealized hurricane-ocean coupled model (Wu et al. 2007). They conducted numerical experiments with different oceanic thermal structures to elucidate the responses of tropical cyclones to the ocean eddy and the effects of tropical cyclones on the ocean. Their idealized model showed that rapid intensification occurs as a storm encounters the ocean eddy due to enhanced heat flux. While strong winds usually cause strong mixing in the mixed layer and thus cool down the sea surface, negative feedback to the storm intensity of this kind is limited by the presence of a warm ocean eddy which provides insulating effect against the storm-induced mixing and cooling. The efficiency of the eddy feedback effect depends on both the oceanic structure and other environment parameters, including properties of the tropical cyclone. They concluded that the mixed-layer depth either associated with the large-scale ocean or with the eddy is the most important factor in determining the magnitude of eddy feedback effect, with the storm's translation speed and the ambient relative humidity playing secondary roles. This study provides clear physical insights into our understanding of the importance of the upper ocean thermal structure in affecting the tropical cyclone intensity.

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Wu, C.-C., C.-Y Lee, and I-I Lin, 2007: The effect of the ocean eddy on tropical cyclone intensity. Journal of the Atmospheric Sciences, 64, 3562-3578.

林依依教授 1989 年自本系大學部畢業後，赴英國劍橋大學攻讀博士，並於 1995 年取得學位；之後前往新加坡大學遙測中心擔任科學家，於 2000 年回台任職於國家海洋科學研究中心擔任助研究員；2004 年 8 月回母校國立臺灣大學大氣科學系擔任助理教授，並於 2006 年升任副教授。研究興趣為利用衛星遙測來探討大氣及海洋物理，以及生物地球化學之交互作用，如探討颱風對海洋的初級生產力可能的影響，以及探討西北太平洋海洋暖渦對幫助颱風增強的角色。

Satellite Remote Sensing Studies on Air-Sea Interaction

The advancement in space-borne remote sensing in the past decade has alleviated some of the difficulties associated with the lack of observations over the vast oceans. Associate Professor I-I Lin is currently leading the efforts of remote sensing studies of atmospheric-ocean interactions in the department. Her research interests include areas such as the typhoon-ocean physical/biogeochemical interaction and the dust storm-ocean interaction.

One example of this research was the analysis of tropical cycle Kai-Tak (2000). Satellite data obtained when Kai-Tak passed over the South China Sea (SCS) provided a special opportunity to quantify the long-speculated contribution of tropical cyclones to enhance ocean primary production. During its 3-day stay, Kai-Tak triggered an average 30-fold increase in surface chlorophyll-a concentration. The estimated carbon fixation resulting from this event alone is 0.8 Mt, or 2 – 4% of SCS's annual new production. Given an average of 14 cyclones passing over the SCS annually, Professor Lin and her colleagues suggested that the long-neglected contribution of tropical cyclones to SCS's annual new production may be as much as 20 – 30%. (Lin et al. 2003).

Professor Lin graduated from the Department in 1989 and received her Ph.D. in remote sensing from the University of Cambridge in 1995. She continued her research in remote sensing first at the Centre for Remote Imaging, Sensing, and Processing, National University of Singapore from 1995-1999 and then at Taiwan's National Center for Ocean Research after she returned to Taiwan in 2000, before joining the NTUAS faculty in 2004.

References:

Lin I-I, W. T. Liu, C-C Wu, G. T.F. Wong, C. Hu, Z. Chen, W-D Liang, Y Yang, and K-K Liu, 2003: New evidence for enhanced ocean primary production triggered by tropical cyclone., *Geophysical Research Letters,* **30,** 1718.

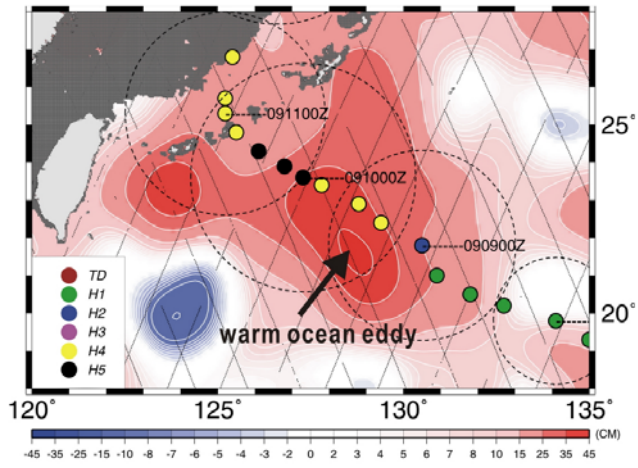
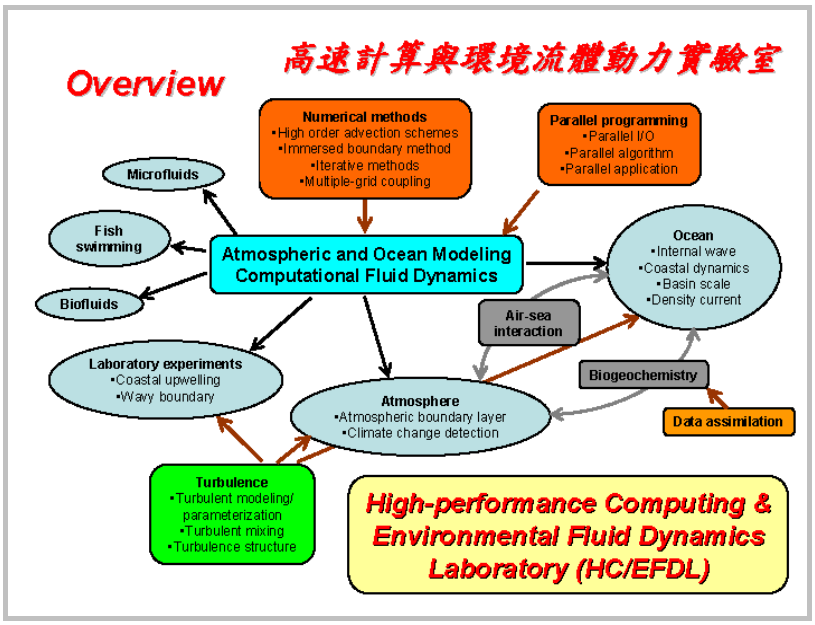


Fig. 3 On 9 September 2003, typhoon Maemi encountered a warm ocean eddy (as characterised by the positive sea surface height anomaly of 10-45cm from satellite altimetry measurements). With in 24 hours, Maemi's intensity shut up from Saffir-Simpson scale category-2 (blue bullet) to the super, category-5 intensity (black bullets) (after Lin et al., 2005).

Research in the High-performance Computing & Environmental Fluid Dynamics Laboratory (HC/EFDL)

The HC/EFDL is being established by Assistant Professor Yu-heng Tseng to conduct research on computational modeling in geophysical fluid dynamics, particularly on applications in oceans and the atmosphere. Professor Tseng's primary expertise is multidisciplinary applications using high-performance computational tools His research involves coastal/global ocean modeling, earth system model development, large-eddy simulation for environmental flows, turbulent mixing and boundary layers, and sub-grid scale modeling and advanced numerical techniques. Professor Tseng, a graduate of NTU Mechanical Engineering Department, received his Ph.D. on Environmental Fluid Mechanics and Hydrology from Stanford University in 2003. Before he joined the Atmospheric Sciences faculty in 2006, he conducted post-doctoral research on large eddy simulations of atmospheric boundary layer at the Johns Hopkins University, and spent two years on Community Climate System Model (CCSM) parallel I/O development at the Lawrence Berkeley National Laboratory.

With the recent advance of numerical tools (such as high-order numerical techniques, multiple-domain coupling and parallel computing resource etc.), he and his students are targeting multi-scales environmental flow applications covering a broad range of spectrum in the computational research. As an example, the ghost-cell immersed boundary method (GC-IBM) developed by him and his colleagues a few years ago at Stanford has been used in many complex geometry applications, such as complex topography in the coastal ocean and urban boundary layer in the atmosphere (e.g. Tseng and Ferziger, 2003; 2004; Tseng et al., 2005). The latest GC-IBM provides more flexibility without sacrificing accuracy, which was used by



Professor Tseng to study the mechanisms of subgrid-scale transport of temperature, humidity, and momentum in complex geometry and simulate the air pollutant transport and dispersion in urban environment (e.g. Tseng et al., 2006). He also applied GC-IBM on the coastal bathymetry and further extended it to the cardiovascular system simulation in biological applications.

Currently, Professor Tseng and his students are working on the complex air-sea interactions involved in modeling the global climate change and the ocean response of typhoons. Better understanding of the ocean mixed layers is crucial in these studies. One of the long-term goals is to develop an efficient multi-scale, multiple-grid, fully two-way coupled global ocean modeling system, within which the attention will be on the subdomain of western North Pacific Ocean where the Kuroshio and the regional circulations near Taiwan play important roles on the basin- to global-scale ocean dynamics (see more details from http://efdl.as.ntu.edu).

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Tseng, Y.-H., C. Meneveau, and M. B. Parlange, 2006: Modeling flow around bluff bodies and urban dispersion using large eddy simulation, *Environmental Science and Technology,* **40,** 2653-2662.

曾于恒教授於 1995 畢業於臺大機械系，2003 年獲美國史丹佛大學博士學位；曾於約翰霍普金斯大學機械系從事博士後研究，之後在柏克萊國家實驗室從事全球氣候模式相關研究；於 2006 年延聘至本系擔任助理教授。研究領域著重於運用及發展各種不同尺度電腦模式探討各類環境流體之動力系統，包含全球氣候變遷之長期影響、大氣海洋間水氣交互作用、全球及北太平洋洋流系統、颱風對北太平洋環流影響、近岸海洋動力與內波；以及利用大渦流模擬(Large Eddy Simulation, LES)大氣邊界層空氣污染傳播與擴散，運用 LES 與紊流理論探討污染物受地形建築影響。此外也發展各種高階、高精確度數值計算方法以及平行計算之技術，並包含生物流體力學應用。

2007 Master's Theses

Chou, Wan-Ting	Evaluation of the impact of the dropwindsonde data in DOTSTAR and other satellite data on typhoon track predictions
Chuang, Hui-Wen	Diurnal variation of clouds over the maritime continent
Hung, Ching-Hui	TC contribution to climate variability in the tropical Western Pacific
Jiang, Hau-Jang	The property of concentric eyewall in typhoons
Kuo, Kun-Huang	The effect of upper-layer trough on the intensity change of tropical cyclones
Lai, Hsien	Southeastward movement of the South Asian/Western North Pacific anticyclone during boreal autumn : interannual-to-interdecadal time scale
Liao, Pei-Chuan	Characteristics of frontal systems over Taiwan area in winter
Lin, Yi-Chiu	Impact of atmospheric input on phytoplankton biomass over NWPO : a preliminary study
Lin, Yi-Chuan	A numerical study of a sea/valley breeze in northern Taiwan
Lin, Yu-Wei	Bay of Bengal onset : the beginning of the Asian summer monsoon
Lo, Hsu-Feng	A numerical study of three-dimensional moist mountain waves
Shen, Yen-Chih	Vortex interaction and structural change
Tang, Pei-Yun	Simulation of precipitation impact from bio-aerosols
Wu, Jia-Hong	Resiliency of concentric eyewall vortex against vertical wind shear

2007 碩士論文

江豪章	雙眼牆颱風之特性探討
沈彥志	渦旋交互作用與結構改變
林宜萩	大氣沉降對西北太平洋海洋浮游植物生物量影響：初探
林育鮪	孟加拉灣雨季肇始：亞洲夏季季風的開端
林奕銓	北台灣海/谷風環流發展之數值研究
周婉婷	DOTSTAR 投落送資料與其他衛星觀測資料對颱風路徑模擬影響之探討：梅姬與卡努颱風個案研究
吳嘉鴻	雙眼牆結構渦旋抗垂直風切能力探討
洪靜慧	西北太平洋地區熱帶氣旋活動對氣候變異度的影響
唐珮耘	生物氣膠影響降水過程之數值模
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