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EDUCATION

2001/09 – 2009/08 Ph.D. Depart. of Atmospheric Sciences, National Taiwan University, Taiwan
1999/09 – 2001/08 M.S. Depart. of Atmospheric Sciences, National Taiwan University, Taiwan
1993/09 – 1997/08 B.S. Depart. of Earth Sciences, National Taiwan Normal University, Taiwan

EMPLOYMENT

2015/02 - present	Assistant Research Fellow	RCEC, Academia Sinica, Taiwan
2013/08 - 2015/01	Assistant Research Scholar	National Taiwan Uni., Taiwan
2009/08 - 2013/07	Postdoctoral Research Fellow	National Taiwan Uni., Taiwan
2003/09 - 2004/05	Visiting scholar	State University of New York, Albany, USA

HONORS & AWARDS

2009 National Science Council's Postdoctoral Fellow Publication Award

PROFESSIONAL SERVICE

- Journal reviewer: Asia-Pacific Journal of Atmospheric Sciences, Atmospheric Environment, Atmospheric Research, Terrestrial, Atmospheric and Oceanic Sciences, International Journal of Environmental Research and Public Health, Journal of Geophysical Research-Atmosphere, Science of the Total Environment

RESEARCH INTEREST

- Aerosol parameterization and modeling
- Aerosol-cloud interactions
- Climate-Chemistry interactions
- Cloud Physics
- Atmospheric Physical Chemistry

RESEARCH HIGHLIGHTS

Tropospheric aerosols account for a small fraction of the mass and volume in the atmosphere; however, they strongly affect radiant energy transfer, cloud and precipitation formation, visibility, biogeochemical cycles, and human health. My research interests are investigating the role of aerosol and cloud in the Earth's system and their interactions. I was recruited as an assistant research fellow in January 2015, and my research has been dedicated to understanding aerosol and cloud microphysical

processes and their effects on climate over East Asia by developing and improving regional models. My work has focused on three areas: aerosol-cloud interactions, aerosol effects on climate, and the risk climate change pose for Taiwan. The accomplishments are highlighted in the following.

■ Aerosol-Cloud Interactions

- Concerning aerosols in Taiwan, I have published papers indicating that (i) biogenic sources and aqueous-phase processes dominated organic aerosol production in northern Taiwan; (ii) the mixing process between sulfate and dust particles can reduce the overall single scattering albedo by up to 10% during a dust event; and (iii) urban aerosols may affect the microphysical properties of fog droplets over the Taiwan Strait in April.
- I improved the transportation emissions inventories covering the Greater Taipei Area by incorporating web-based traffic information and implementing a vision-based traffic analysis system. The simulation results indicated that the addition of real-time traffic data improved the air quality model's performance, especially for CO and PM_{2.5} concentrations.
- In collaboration with National Taiwan University, I performed kinetic calculations of isotope fractionation due to various microphysical phase-change processes in clouds into a regional model. Different factors controlling isotopic composition, including water vapor sources, atmospheric transport, phase transition pathways of water in clouds, and kinetic versus equilibrium mass transfer, contributed significantly to variations in isotope composition. This work advanced our understanding of the stable isotopocules of water, informing the understanding of the water cycle.
- I employed the homemade aerosol parameterization scheme in the Taiwan Earth System Model (TaiESM) to increase Taiwan's climate modeling capability and capacity. After verification through reanalysis data and observations, TaiESM can comprehensively reproduce a robust climatological state and near-surface aerosol concentrations. Most large-scale circulations and precipitation were accurately simulated in the historical simulation, and TaiESM is now registered as one of the models in the sixth phase of the Coupled Model Intercomparison Project.

■ Aerosol Effects on Climate

The effect of aerosols on summer and winter Asian monsoons were investigated by improving and conducting earth system model simulations. Anthropogenic aerosols were shown to (i) weaken East Asia's summer monsoon due mainly to the southward shift of the 200 hPa East Asia Jet and the decrease in 850 hPa winds; (ii) weaken and strengthen the intensity of the Aleutian Low and the Siberian High, respectively, resulting in a weakened East Asia Winter Monsoon (EAWM) in the lower atmosphere over the extratropical areas. The tropical rain belt shifts southward for the southern area, representing the Hadley circulation change, and the precipitation is decreased in southern Asia.

■ Risk of Climate Change in Taiwan

By conducting high-resolution simulations, I estimated the effect of climate change on Taiwan under 2 °C and 4 °C warming climate. We indicated (i) the number of heatwaves over urban areas increased more quickly than over other land-use types, and forests were less vulnerable to global warming; (ii) the warming climate worsens the polluted days in Taiwan due to weaker near-surface wind; and (iii) the warming climate reduced the relative yield for wheat, tomatoes, and potatoes. The O₃-induced relative yield reduction dominated the additional yield reduction for a 2 °C warming climate, but climate-induced relative yield prevailed under 4 °C warming.

PUBLICATIONS (*: corresponding author)

Manuscripts (under review) :

1. Yang, S.-W., **I-C. Tsai***, C.-J. Shiu, Y.-Y. Chen, W.-L. Lee, and H.-H. Hsu, 2022: Impacts of aerosols on the East Asia Winter Monsoon in the TaiESM model. (Climate Dynamics, in revision)

Peer-reviewed papers:

2. Y.-C. Chen, P.-H. Lin, W.-N. Chen, **I-C. Tsai**, S. Laplace, C.-C. Ting, C. Fu, Charles, C.-K. Chou, 2022: Decade long-term measurement for investigating vertical thermodynamic of urban boundary layer, *Urban Climate*, 46, 2022, 101301, <https://doi.org/10.1016/j.uclim.2022.101301>.
3. **Tsai, I-C.***, P.-R. Hsieh, C.-T. Cheng, Y.-S. Tung, L.-Y. Lin and H.-H. Hsu, 2022: Impacts of 2 and 4 °C global warmings on extreme temperatures in Taiwan, *International Journal of Climatology*. <https://doi.org/10.1002/joc.7815>.
4. **Tsai, I-C.**, L.-S. Shu, J.-P. Chen, P.-R. Hsieh, and C.-T. Cheng, 2022: Projecting ozone impact on crop yield in Taiwan under climate warming, *Science of the Total Environment*, 846 (2022), 157437, <https://doi.org/10.1016/j.scitotenv.2022.157437>.
5. S.-Y. Lee, S.-C. C. Lung, P.-G. Chiu, W.-C. Wang, **I-C. Tsai**, T.-H. Lin, 2022: Northern hemisphere urban heat stress and associated labor hour hazard from ERA5 reanalysis. *Int. J. Environ. Res. Public Health*. 2022, 19, 8163. <https://doi.org/10.3390/ijerph19138163>
6. **Tsai, I-C.***, P.-R. Hsieh, H. C. Cheung, and C. C.-K. Chou, 2021: Aerosol impacts on fog microphysics over the western side of Taiwan Strait in April from 2015 to 2017, *Atmospheric Environment*, 118523, <https://doi.org/10.1016/j.atmosenv.2021.118523>.
7. **Tsai, I-C.***, C.-Y. Lee, S.-C. C. Lung, C.-W. Su, 2021: Characterization of the vehicle emissions in the Greater Taipei Area through vision-based traffic analysis system and its impacts on urban air quality, *Science of the Total Environment*, 782(2021), 146571, ISSN 0048-9697, <https://doi.org/10.1016/j.scitotenv.2021.146571>.
8. Lee, W.-L., Y.-C. Wang, C.-J. Shiu, **I-C. Tsai**, C.-Y. Tu, Y.-Y. Lan, J.-P. Chen, H.-L. Pan, and H.-H. Hsu, 2020: Taiwan Earth System Model Version 1: description and evaluation of mean state, *Geosci. Model Dev.*, 13, 3887–3904, <https://doi.org/10.5194/gmd-13-3887-2020>.
9. Zhang, L., T.-M. Fu, H. Tian, Y. Ma, J.-P. Chen, T.-C. Tsai, **I-C. Tsai**, Z. Meng, X. Yang. 2020: Anthropogenic Aerosols Significantly Reduce Mesoscale Convective System Occurrences and Precipitation over Southern China in April, *Geophysical Research Letters*. 47, e2019GL086204. <https://doi.org/10.1029/2019GL086204>.
10. Wu, C.-H., **I-C. Tsai**, P.-C. Tsai and Y.-S. Tung, 2019: Large-Scale Seasonal Control of Air Quality in Taiwan, *Atmospheric Environment*, 214, 116868, doi:<https://doi.org/10.1016/j.atmosenv.2019.116868>.
11. Huang C.-C., S.-H. Chen, Y.-C. Lin, K. Earl, T. Matsui, H.-H. Lee, **I-C. Tsai**, J.-P. Chen, C.-T. Cheng, 2019: Impacts of Dust-Radiation versus Dust-Cloud Interactions on the Development of a Modeled Mesoscale Convective System over North Africa. *Monthly Weather Review*, 147, 3301–3326, <https://doi.org/10.1175/mwr-d-18-0459.1>.
12. **Tsai, I-C.***, W.-Y. Chen, J.-P. Chen, and M.-C. Liang, 2019: Kinetic mass-transfer calculation of water isotope fractionation due to cloud microphysics in a regional meteorological model, *Atmos. Chem. Phys.*, 19, 1753-1766, <https://doi.org/10.5194/acp-19-1753-2019>.

13. Lung, S.-C., S.-W. Chou, J.-P. Chen, P.-C. Wen, H.-J. J. Su, **I-C. Tsai**, and Y.-S. Shen, 2018: Science Plan of “Climate Change and Health Adaptation”, *Journal of Taiwan Land Research*, 21, 2, 209-239 (in Chinese).
14. **Tsai, I-C.***, W.-C. Wang, H.-H. Hsu, and W.-L. Lee, 2016: Aerosol effects on summer monsoon over Asia during 1980s and 1990s, *J. Geophys. Res. Atmos.*, 121, 11761–11776, doi:10.1002/2016JD025388.
15. Chen, J.-P., I-J. Chen and **I-C. Tsai**, 2016: Dynamic feedback of aerosol effect on the East Asian summer monsoon. *Journal of Climate*, 29(17):6137-6149. Li, N., J.-P. Chen*, **I-C. Tsai**, Q. He, S.-Y. Chi, Y.-C. Lin, and T.-M. Fu, 2016: Potential impacts of electric vehicles on air quality in Taiwan. *Science of the Total Environment*, 566-567(2016).
16. **Tsai, I-C.**, J.-P. Chen, C. S.-C. Lung, N. Li, W.-N. Chen, T.-M. Fu, C.-C. Chang, and G.-D. Hwang, 2015: Sources and formation pathways of organic aerosol in a subtropical metropolis during summer. *Atmospheric Environment*, 117, 51-60.
17. **Tsai, I-C.**, J.-P. Chen, Y.-C. Lin, C C.-K. Chou, and W.-N. Chen, 2015: Numerical investigation of the coagulation mixing between dust and hygroscopic aerosol particles and its impacts. *Journal of Geophysical Research: Atmospheres*, 120, 9, 4313-4233, doi:10.1002/2014JD022899.
18. Chen, J.-P., C.-E. Yang and **I-C. Tsai**, 2015: Estimation of foreign versus domestic contributions to Taiwan's air pollution. *Atmospheric Environment*, 112,9-19, doi:10.1016/j.atmosenv.2015.02.022
19. Lin, Y.-C., J.-P. Chen, T.-Y. Ho and **I-C. Tsai**, 2015: Atmospheric Iron deposition in the Northwestern Pacific Ocean and its Adjacent Marginal Seas: the Importance of Coal Burning. *Global Biogeochemical Cycles*, 29, 139–159, doi:10.1002/2013GB004795.
20. Chen, J.-P., **I-C. Tsai**, and Y.-C. Lin, 2013: A statistical–numerical aerosol parameterization scheme, *Atmos. Chem. Phys.*, 13, 10483-10504, doi:10.5194/acp-13-10483-2013.
21. **Tsai, I-C.**, M.-C. Liang, and J.-P. Chen, 2012: Methane-Nitrogen binary nucleation: a new microphysical mechanism for cloud formation in Titan's atmosphere. *Astrophys. J.*, 747.
22. **Tsai, I-C.**, J.-P. Chen, P.-Y. Lin, W.-C. Wang and I. S. A. Isaksen, 2010: Sulfur cycle and sulfate radiative forcing simulated from a coupled global climate-chemistry model. *Atmos. Chem. Phys.*, 10, 3693-3709.
23. Chen, J.-P., Z. Wang, C.-Y. Young, F. Tsai, **I-C. Tsai**, G.-J. Wang, W.-C. Shieh, H.-W. Lin, J.-Y. Huang, and M.-J. Lu, 2004: Simulations of Asian Yellow Dust Incursion Over Taiwan for the Spring of 2002 and 2003, *Terrest. Atmos. Ocean. Vol 15*, No. 5, 949-981.

Book and Chapter in Book

1. Wang, W.-C., J.-P. Chen, I. S. A. Isaksen, **I-C. Tsai**, K. Noone and K. McGuffie, 2012: Climate-chemistry interaction: Future tropospheric ozone and aerosol. In A. Henderson-Sellers and K. McGuffie (eds): *The Future of the World's Climate*. World Survey of Climatology series, Elsevier Science, ISBN: 978-0-12-386917-3, pp. 367-399. (2012 ASLI Choice Award)
2. Chen, J.-P., A. Hazra, C.-J. Shiu, **I-C. Tsai**, and H.-H. Lee, 2008: Interaction between aerosols and clouds: current understanding. In Liou, K.-N., M.-D. Chou and H.-H. Hsu (eds.): *Recent*

Conference Proceedings:

1. Tsai, I-C., J.-P. Chen, H.-M. Hung, C. C.-K. Chou, and W.-N. Chen, 2017: Numerical investigation of Enhanced Sulfate Formation Over mountain areas in Central Taiwan. AOGS 2017, Aug. 6-11, Singapore, Singapore.
2. Tsai, I-C., J.-P. Chen, and C.-Y. Yang, 2016: Simulation of tropical cyclones response to aerosol type. 17th International Conference on Clouds and Precipitation (ICCP). July 25-29, 2016, Manchester, UK.
3. Tsai, I-C., W.-C. Wang, W.-L. Lee, and H.-H. Hsu, 2016: Aerosol-monsoon interactions over East Asia: A study using changes in anthropogenic aerosol emissions during 1980s and 1990s. East Asian Climate 13th workshop. March 24-25, Beijing, China
4. Tsai, I-C., W.-T. Chen, C.-Y. Yang and J.-P. Chen, 2014: Evaluation of Fog Simulation Capability by Several Cloud Microphysical Schemes in the WRF Model. Fall Meeting of the AGU. December 15-19, San Francisco, California, USA.
5. Chen, J.-P., I-C. Tsai, W.-Y. Chen and M.-C. Liang, 2014: Simulation of cloud microphysical effects on water isotope fractionation in a frontal system. Fall Meeting of the AGU. December 15-19, San Francisco, California, USA.
6. Tsai, I-C., J.-P. Chen, Y.-C. Lin, C. C.-K. Chou and W.-N. Chen, 2014: Numerical investigation of the internal mixing between dust and hygroscopic aerosol particles and its impacts. Tenth East Asia Climate and Environment (EACE10) workshop. April 17-18, Beijing, China.
7. Chen, J.-P., I.-J. Chen, and I-C. Tsai, 2014: Aerosol impacts on East Asian Summer Monsoon. Tenth East Asia Climate and Environment (EACE10) workshop. April 17-18, Beijing, China.
8. Wang, C.-Y., J.-P. Chen and I-C. Tsai, 2013: The impacts of future climate change on surface ozone. Fall Meeting of the AGU. December 9-13, San Francisco, California, USA.
9. Shiu, C.-J., Y.-H. Chen, W.-T. Chen, J.-L. F. Li, I-C. Tsai, J.-P. Chen and H.-H. H, 2013: Implementing a warm cloud microphysics parameterization for convective clouds in NCAR CESM. Fall Meeting of the AGU. December 9-13, San Francisco, California, USA.
10. Tsai, I-C., G.-D. Hwang, C. C.-K. Chou, W.-N. Chen, C.-C. Chang, S.-C. C Lung and J.-P. Chen, 2012: Numerical simulation of organic aerosol at a rural site near the Taipei City in Taiwan, IGAC Conference 2012, 17-21 September, 2012, Beijing, China.
11. Tsai, I-C., Y.-C. Lin, S.-C. Hsu, and J.-P. Chen, 2012: Simulation and evaluation of rain scavenging process. 16th International Conference on Clouds and Precipitation (ICCP), 30 July-03 August, 2012, Leipzig, Germany.
12. Chen, J.-P., I-C. Tsai, and Y.-C. Lin, 2011: Impacts of aerosol on clouds. Symposium on Air Pollution & Climate: A Science-Policy Dialogue in Asia, 07 November, 2011, Taipei, Taiwan.
13. Chen, J.-P., I-C. Tsai, and Y.-C. Lin, 2011: Impacts of dust mixing state on radiation and cloud microphysics. 8th Annual Meeting of the Asia Oceania Geosciences Society, 08-12 August, 2011, Taipei, Taiwan.

14. Tsai, I-C., J.-P. Chen, C.-J. Shiu, W.-N. Chen and C. C.-K. Chou, 2011: Simulation of aerosol mixing state in a dust event over Taiwan. 2011 International Union of Geodesy and Geophysics (IUGG) Conference, 28 June-7 July, Melbourne, Australia.
15. Chen, S.-H., C. -T. Cheng, J. -P. Chen, Y. -C. Lin, H. -H. Lee, and I-C. Tsai, 2011: The Influence of Dust-microphysics Processes on Tropical Cyclone Development. 2011 International Union of Geodesy and Geophysics (IUGG) Conference, 28 June-7 July, Melbourne, Australia.
16. Chen, J.-P. and I-C. Tsai, 2010: Aerosol mixing state simulated with a physically-based three-moment modal aerosol parameterization scheme. Fall Meeting of the AGU, December 13-17, San Francisco, California, USA.
17. Tsai, I-C. and J.-P. Chen, 2010: Simulation of dust mixture state and its impacts. 「第七屆海峽兩岸氣膠技術研討會暨第二屆空氣污染技術研討會」, Nov. 22-23, 2010, 中央研究院
18. Liang, M.-C., I-C. Tsai and J.-P. Chen, 2010: Aerosol formation in the atmospheres of Titan and Venus. 7th Annual Meeting of the Asia Oceania Geosciences Society, 5-9 July, Hyderabad, India.
19. Tsai, I-C., J.-P. Chen and M.-C. Liang, 2010: Aerosol formation in the atmospheres of Titan and Venus. 2010 Western Pacific Geophysics Meeting, 22-25, June, Taipei, Taiwan. [invited talk]
20. Chen, J.-P., Y.-C. Lin and I-C. Tsai, 2010: Deposition of mineral dust and anthropogenic pollutants over NWPO and SCS. 2010 Western Pacific Geophysics Meeting, 22-25, June, Taipei, Taiwan.
21. Chen, J.-P., and I-C. Tsai, 2010: Simulating the influence of Kelvin effect and mixing state on the radiative properties of aerosols. 「海峽兩岸亞洲地區城市化及其環境、氣候影響」學術研討會, Jan. 19-20, 2010, 中央研究院。
22. Chen, J.-P., and I-C. Tsai, 2009: Application of a physically-based aerosol parameterization scheme in studying aerosol mixing state. IGAC-SPARC Joint Workshop, Kyoto, Oct. 25-26, 2009.
23. Tsai, I-C., P.-Y. Tang and J.-P. Chen, 2009: Studying the impact of Kelvin effect in aerosol water content by a bulk aerosol parameterization. 6th Annual Meeting of the Asia Oceania Geosciences Society, Singapore, 11-15 August, 2009.
24. Tsai, I-C., and J.-P. Chen, 2009: Physically-based bulk aerosol parameterization. 6th Annual Meeting of the Asia Oceania Geosciences Society, Singapore, 11-15 August, 2009.
25. Lin, Y.-C., I-C. Tsai and J.-P. Chen, 2009: Asian dust deposition over NWPO and SCS. 6th Annual Meeting of the Asia Oceania Geosciences Society, Singapore, 11-15 August, 2009.
26. Hazra, A., I-C. Tsai, and J.-P. Chen, 2009: Some effects of cloud-aerosol interaction and aerosol scavenging with by ice hydrometeors on cloud microphysics and precipitation formation. 6th Annual Meeting of the Asia Oceania Geosciences Society, Singapore, 11-15 August, 2009.
27. Tsai, I-C., and J.-P. Chen, 2008: Application of Physically-Based Bulk aerosol parameterization into a regional air quality model. IGAC Conference 2008, 7-12 September, Annecy, France.
28. Tsai, I-C., J.-P. Chen, W.-C. Wang and I. S. A. Isaksen, 2008: Sulfate direct and indirect effects simulated with the coupled Global Climate-Chemistry Model. IGAC Conference 2008, 7-12 September, Annecy, France.

29. Tsai, I-C., J.-P. Chen, P.-Y. Lin, W.-C. Wang and I. S. A. Isaksen, 2007: Estimating sulfate aerosol-climate interactions by a Global Climate-Chemistry Model with focus on East Asia. Seventh Workshop on East Asia Chemistry and Climate, Jun 18-20 2007, Oslo, Norway.
30. Chen, J.-P., Tsai, I-C., P.-Y. Lin, and W.-C. Wang, 2006: GCCM simulation of aerosol-climate interactions. *Atmospheric Chemistry at the Interface, Joint CACGP/IGAC/WMO Symposium*, September 17-22, Cape Town South Africa.
31. Chen, J.-P., I-C. Tsai, W.-C. Wang, P.-Y. Lin, and I.S.A. Isaksen, 2006: GCCM simulation of aerosol-climate interaction with focus on the East Asia Region. *Eighth AMIP/East Asian Climate Workshop*, 31 March – 1 April, Nantou, Taiwan.
32. Wang, W.-C., I. S. A. Isaksen, T. Liang, I-C. Tsai, J.-P. Chen, and T. K. Berntsen, 2005: A global tropospheric climate-chemistry model study of the radiative forcing from changes in tropospheric O₃ and sulfate aerosols. 2005 Scientific Assembly of the International Association of Meteorology and Atmospheric Sciences, August 2-11, Beijing.
33. Tsai, I-C., H.-H. Lee, and J.-P. Chen, 2005: Dust model with modal parameterization and application in the East Asia region. 2005 Scientific Assembly of the International Association of Meteorology and Atmospheric Sciences, August 2-11, Beijing.