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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

My primary research accomplishments were relevant to tropospheric aerosols and clouds, including their microphysical processes, interactions with climate, air quality issues, and their impacts on the biosphere. Since 2016, my publications are based on past research and ongoing projects and divided into two parts: development and application of aerosol and cloud microphysics

parameterizations and impacts of aerosol and cloud on climate and air quality issues. The accomplishments are summarized below:

1. Development and application of aerosol and cloud microphysical parameterizations:

- **Kinetic mass-transfer calculation of water isotope fractionation due to cloud microphysics**: Information about the stable isotopocules of water helps understand the water cycle. In conventional atmospheric models, isotope exchange between liquid and gas phases is usually assumed to be in equilibrium, and the highly kinetic phase transformation processes inferred in clouds are yet to be thoroughly investigated. In Tsai et al. (2019), I modified the NCAR Weather Research and Forecasting (WRF) Model to allow kinetic calculation of isotope fractionation due to various cloud microphysical phase-change processes. From the sensitivity tests, we found that 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 the variations in isotope composition.
- **Implementation of the homemade aerosol parameterization to Taiwan Earth System Model**: The Taiwan Earth System Model (TaiESM) was primarily developed by RCEC (Lee et al., 2020) and is registered as one of the models in the sixth phase of the Coupled Model Intercomparison Project (CMIP6). I took responsibility for implementing the homemade aerosol parameterization SNAP (Chen et al., 2013) to TaiESM. Unlike the two-moment schemes widely used in conventional global models, the three-moment (0^{th}, $2^{nd,}$ and 3^{rd} moments) approach adopted in SNAP can represent the aerosol distribution without other assumptions. The TaiESM was verified with observations and subsequently used to tackle the impact of aerosols and clouds on the weather and climate system.
- **Aerosol-cloud interactions in mesoscale convective systems:** I collaborated with other groups to apply our parameterizations in regional models to study the aerosol-cloud interactions. Zhang et al. (2020) using observation analyses and model simulations to study the rainfall over Southern China in April. We found that the occurrences of strong, well-organized mesoscale convective systems (MCS) were suppressed by higher levels of aerosols, leading to decreased rainfall. Huang et al. (2019) studied the impacts of dust–radiation–cloud interactions on developing MCS by WRF model coupled with an online dust module. The results indicate that the dust–radiation effect has a more significant influence on the MCS's development than the dust–cloud effect.
- **Improving the emission inventory in the air quality model**: Fine particulate matter from vehicle emissions is receiving increasing attention in assessments of aerosol-cloud interactions, air pollution, and the associated health risks. Tsai et al. (2021) apply a vision-based traffic analysis system to obtain traffic data from the surveillance camera images. The traffic data were normalized and added to the CMAQ model to study the impact of vehicle emissions on air quality in the Greater Taipei Area. The connection between the surveillance camera data, vehicle emissions, and regional air quality models in this study can also be used to explore the impact of special events (e.g., long weekends and COVID-19 lockdowns) on air quality.

2. Impacts of aerosol and cloud on climate and air quality issues:

Besides model developments, I also extended my research to study aerosol and cloud impacts on climate and air quality issues.

- **Aerosol impacts on Asia summer monsoon**: We studied the impacts of aerosol on East Asia summer monsoon by using the National Center for Atmospheric Research Community Earth System Model (Chen et al., 2016; Tsai et al., 2016). Uncertainties from aerosol–climate interaction effects

were addressed in terms of model variability and warming effects. For the warming effects, aerosols reduced the global mean of warming from greenhouse gases, but the results differed regionally. Nevertheless, aerosol–climate interaction effects persist when the climate becomes warmer, although strength and geographical distribution vary slightly (Tsai et al., 2016).

- **Large-scale circulations over East Asia during polluted days**: I collaborated with my colleagues to analyze the large-scale circulations over East Asia during polluted and nonpolluted days. We investigated the dynamic mechanisms of seasonal air quality over Southern and Northern Taiwan (Wu et al., 2019).
- **Impacts of electric vehicle penetration on air quality in Taiwan**: The prospective impacts of electric vehicle (EV) penetration on air quality in Taiwan were evaluated using an air quality model with the assumption of an ambitious replacement of current light-duty vehicles under different powering scenarios (Li et al., 2016). From the simulation results, the penetration of EV would reduce the mean peak time surface O_3 concentration by up to 7 ppb widely across Taiwan, except the center of metropolitan Taipei.

REPRESENTATIVE PUBLICATIONS

Refereed Paper

1. **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, doi:https://doi.org/10.1016/j.atmosenv.2021.118523
2. **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.
3. 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.
4. 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.
5. 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.
6. 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.

7. **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.
8. 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).
9. **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.
10. 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.
11. 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), 919-928.
12. **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.
13. **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.
14. 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.
15. 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.
16. 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.
17. **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**.
18. **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.
19. 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 Progress in Atmospheric Sciences: Application to the Asia-Pacific Region*. World Scientific, ISBN-13 978-981-281-890-4, QC861.3.R43, pp. 231-281

Conference and Workshop

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