Zhiquan (Jake) Liu

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EDUCATION

Paul Sabatier University (Toulouse III), Toulouse, France
- Ph. D. in Meteorology, November 2002
- Thesis**: *Influence of the observation resolution on data assimilation***
- Thesis Adviser: Dr. Florence Rabier

L'Ecole Nationale de la Météorologie, Toulouse, France
- M. S. in Numerical Weather Prediction, December 1998

The Nanjing University, Nanjing, China
- B. S. in Atmospheric Physics, July 1994

PROFESSIONAL EXPERIENCE

Mesoscale and Microscale Meteorology (MMM) Laboratory, National Center for Atmospheric Research (NCAR), Boulder, CO
- Deputy head of PARC Section, February 2017 – Present
- Manager of WRF Data Assimilation program, August 2014 – present
- Project Scientist IV, March 2020 – Present
- Project Scientist III, May 2012 – February 2020
- Project Scientist II, August 2006 – May 2012
- Visiting Scientist, June 2005 – July 2006

National Satellite Meteorological Center, China Meteorological Administration, Beijing
- Senior Research Scientist and Head of atmospheric sounding and data assimilation branch, 2004 – 2007 (on leave between June 2005 and January 2007)
- Research Scientist, 1994 – 2003

HONORS AND AWARDS

One of recipients for 2020 American Meteorology Society THE KENNETH C. SPENGLER AWARD "*For enabling and supporting a community of research and operational weather modeling through the Advanced Research version of the Weather Research and Forecasting Model (WRF-ARW)*"

The Ministry of Science and Technology of the People's Republic of China

- One of recipients for the national award (the second ranking) of the "*National Advancement of Science and Technology*" for the contributions to the project "*Chinese New Generation Multiscale Numerical Weather Prediction System*", 2007

China Meteorological Administration

- One of recipients for the award (the first ranking) of the "*Scientific Research and Technical Achievement*" for the contributions to the project "*Design and Applications of a limited-area three-dimensional variational assimilation system (GRAPES-3DVAR)*", 2004

Chinese Meteorological Society

- Award (the second ranking) of the 11th "*Tu Changwang Young Scientist*", 2004-2005

COMMITTEE MEMBERSHIP AND COMMUNITY SERVICE

- Associate Editor of JGR-Atmosphere, 01/01/2018-12/31/2020
- Editor of Atmospheric and Oceanic Science Letters, 10/2015-05/2019
- Editor of Journal of Meteorological Research, since March 2017
- WRF Developer Committee member since 2017
- WRF Release Committee member since 2017
- GSI Review Committee Member, since August 2015
- Reviewer of NSF, NASA, NOAA proposals
- Reviewer of peer-reviewed journals QJRMS, JGR, MWR, WAF, MAP, ACP, GMD, Tellus, AAS
- Scientific Organizing Committee member of the 5th International Conference on Reanalysis (ICR5), 13-17 November 2017
- Organizer and instructor of WRFDA tutorials

PEER-REVIEWED PUBLICATIONS: WEATHER RELATED

1. Xu, D. M., **Z. Liu**, S. Y. Fan, M. Chen, and F. F. Shen, 2021: Assimilating all-sky infrared radiances from Himawari-8 using the 3DVar method for the prediction of a severe storm over North China. *Adv. Atmos. Sci.,* 38(4), 661-676.
2. **Liu, Z**., J. Ban, J.-S, Hong, and Y.-H. Kuo, 2020: Multi-resolution incremental 4D-Var for WRF: Implementation and application at convective scale, *Q. J. R. Meteorol. Soc.*, 146, 3661-3674.
3. Wu, Y., **Z. Liu**, and D. Li, 2020: Improving Forecasts of the Record-Breaking Guangzhou "57" Rainstorm by Assimilating Every 10-min AHI Radiances with WRF 4DVAR, *Atmospheric Research,* 239, 104912.

4. Qiao, X., S. Wang, C. S. Schwartz, **Z. Liu**, and J. Min, 2020: A method for probability matching based on the ensemble maximum for quantitative precipitation forecasts. Mon. Wea. Rev., 148, 3379-3396.
5. Wang, S. and **Z. Liu**, 2019: A Radar Reflectivity Operator with Ice-Phase Hydrometeors for Variational Data Assimilation and Its Evaluation with Real Radar Data. *Geosci. Model Dev.,* 12, 4031-4051.
6. Yao, B., C. Liu, Y. Yin, **Z. Liu**, C. Shi, H. Iwabuchi, and F. Weng, 2019: Assessment of reanalysis on cloudy atmosphere with satellite observations over East Asia, *Atmos. Meas. Tech*., 13, 1033-1049.
7. Gao, F., **Z. Liu**, J. Ma, N.A. Jcaobs, P.P Childs, and H. Wang, 2019: Variational Bias Correction of TAMDAR Temperature Observations in the WRF Data Assimilation System. *Mon. Wea. Rev.*, **147**, https://doi.org/10.1175/MWR-D-18-0025.1.
8. Bromwich, D. H., A. B. Wilson, L. Bai, **Z. Liu**, M. Barlarge, C.-F. Shih, S. Maldonado, K. M. Hines, S.-H. Wang, J. Woollen, B. Kuo, H.-C. Lin, T.-K. Wee, M. C. Serreze, and J. E. Walsh, 2018: The Arctic System Reanalysis Version 2. *Bull. Amer. Meteor. Soc.*, 99, 805-828.
9. Wang, P., J. Li, B. Lu, T. J. Schmit, J. Lu, Y.-K. Lee, J. Li, and **Z. Liu**, 2018: Impact of Moisture Information From Advanced Himawari Imager Measurements on Heavy Precipitation Forecasts in a Regional NWP Model. *J. Geophys. Res. Atmos*.,**123**, 6022-6038.
10. Wang, Y., **Z. Liu**, S. Yang, J. Min, L. Chen, Y. Chen, and T. Zhang, 2018: Added value of assimilating Himawari-8 AHI water vapor radiances on analyses and forecasts for "7.19" severe storm over north China. *J. Geophys. Res. Atmos*., **123,** https://doi.org/10.1002/2017JD027697**.**
11. Ban, J., **Z. Liu**, X. Zhang, X.-Y. Huang, and H. Wang, 2017: Precipitation data assimilation in WRFDA 4D-Var: implementation and application to convection-permitting forecasts over United States. *Tellus A: Dynamic Meteorology and Oceanography*, **69:1**, 1368310.
12. Powers, J. G., J. B., Klemp, W. C. Skamarock, C. A. Davis, J. Dudhia, D. O. Gill, J. L. Coen, D. J. Gochis, R. Ahmadov, S. E. Peckham, G. A. Grell, J. Michalakes, S. Trahan, S. G. Benjamin, C. R. Alexander, G. J. Dimego, W. Wang, C. S. Schwartz, G. S. Romine, **Z. Liu**, C. Snyder, F. Chen, M. J. Barlage1, W. Yu, and M. G. Duda , 2017: The Weather Research and Forecasting (WRF) Model: Overview, System Efforts, and Future Directions. *Bull. Amer. Meteor. Soc*., **98**, 1717-1737.
13. Yang, C., **Z. Liu**, F. Gao, P. Childs, and J. Min, 2017: Impact of Assimilating GOES Imager Radiance with A Rapid Refresh Assimilation System for Convection-Permitting Forecast over Mexico**,** J. Geophys. Res. Atmos., 122, 5472–5490.
14. Yang, C., **Z. Liu**, J. Bresch, S.R.H. Rizvi, X.-Y. Huang, and J. Min, 2016: AMSR2 all-sky radiance assimilation and its impact on the analysis and forecast of Hurricane Sandy with a limited-area data assimilation system. Tellus A, 68, 30917.

15. Xing, J., J. Shi, Y. Lei, X.-Y. Huang, and **Z. Liu**, 2016: Evaluation of HY-2A Scatterometer Wind Vectors Using Data from Buoys, ERA-Interim and ASCAT during 2012–2014. Remote Sensing, *8*(5), 390.
16. Schwartz, C.S., **Z. Liu**, and Xiang-Yu Huang, 2015: Sensitivity of Limited-Area Hybrid Variational-Ensemble Analyses and Forecasts to Ensemble Perturbation Resolution. *Mon. Wea. Rev.*, **143**, 3454–3477.
17. Newman, K.M., C.S. Schwartz, **Z. Liu**, H. Shao, and X.-Y. Huang, 2015: Evaluating forecast impact of assimilating Microwave Humidity Sounder (MHS) radiances with a regional ensemble Kalman filter data assimilation system. *Weather and Forecasting*, 30, 964-983.
18. Zheng, J., J. Li, T. J. Schmit, J. L. Li, and **Z. Liu**, 2015: The impact of AIRS atmospheric temperature and moisture profiles on hurricane forecasts: Ike (2008) and Irene (2011). *Adv. Atmos. Sci.,* 32(3), 319-335.
19. Xu, D., Huang, X.-Y., **Liu, Z.,** Min, J. 2014: Comparisons of Two Cloud Detection Schemes for Infrared Radiance Observations. *Atmospheric and Oceanic Science Letters,* 7(4), 358-363.
20. Schwartz, C. S. and **Z. Liu**, 2014: Convection-permitting forecasts initialized with continuously cycling limited-area 3DVAR, ensemble Kalman filter, and "hybrid" variational-ensemble data assimilation systems. *Mon. Wea. Rev.*, 142, 716-738.
21. Xu, D., **Z. Liu**, X.-Y. Huang, J. Min, and H. Wang, 2013: Impact of Assimilating IASI Radiance Observations on Forecasts of Two Tropical Cyclones. *Meteorology and Atmospheric Physics*, 122, 1-18.
22. Schwartz, C. S., **Z. Liu**, X.-Y. Huang, Y.-H. Kuo, and C.-T. Fong, 2013: Comparing limited-area 3DVAR and hybrid variational-ensemble data assimilation methods for typhoon track forecasts: Sensitivity to outer loops and vortex relocation. *Mon. Wea. Rev.*, 141, 4350-4372.
23. **Liu, Z.**, C. S. Schwartz, C. Snyder, and S.-Y. Ha, 2012: Impact of assimilating AMSU-A radiances on forecasts of 2008 Atlantic tropical cyclones initialized with a limited-area ensemble Kalman filter. *Mon. Wea. Rev.,* **140**, 4017-4034.
24. Schwartz C. S., **Z. Liu**, Y. Chen, and X.-Y. Huang, 2012: Impact of assimilating microwave radiances with a limited-area ensemble data assimilation system on forecasts of typhoon Morakot. *Wea. Forecasting*, **27**, 424–437.
25. Wee, T. K., Y. H. Kuo, D.-K. Lee, **Z. Liu**, W. Wang, and S.-Y. Chen, 2012: Two Overlooked Biases of the Advanced Research WRF (ARW) Model in Geopotential Height and Temperature. *Mon. Wea. Rev.*, **140**, 3907-3918.
26. Barker D. M., X.-Y. Huang, **Z. Liu**, T. Auligne, X. Zhang, S. Rugg, A. A. AL KATHERI, A. Bourgeios, J. Bray, Y. Chen, M. Demirtas, Y. Guo, T. Henderson, W. Huang, H.-C. Lin, J. Michalakes, S. Rizvi, X.-Y. Zhang, 2011: The Weather Research and Forecasting (WRF) Model's Community Variational/Ensemble Data Assimilation System: WRFDA. *Bull. Amer. Meteor. Soc.*, **93**, 831-843.
27. He W., **Z. Liu,** and H. Cheng, 2011: Influence of Surface Temperature and Emissivity on AMSU-A Assimilation Over Land. *Acta Meteor. Sinica*, **25(5)**, 547-557. doi: 10.1007/s13351-011-0501-1.

28. Lu, Q., W. Zhang, P. Zhang, X. Wu, F. Zhang, **Z. Liu**, and D. M. Barker, 2010: Monitoring the 2008 cold surge and frozen disasters snowstorm in South China based on regional ATOVS data assimilation. *Sci. China Earth Sci.*, **53**, 1216-1228. doi: 10.1007/s11430-010-3040-1.
29. Xu, J., Rugg, S., Brerle, and **Z. Liu**, 2009: Weather forecast by the WRF-ARW model with GSI data assimilation system in the complex terrain areas of southwest Asia. *Weather and Forecasting*, 24, 987-1008.
30. Xue J., Zhuang S., Zhu G., Zhang H., **Z. Liu**, Liu Y., and Zhuang Z., 2008: Scientific design and preliminary results of three-dimensional variational data assimilation system of GRAPES. China Science Bulletin, No. 22, Vol. 53, 3446-3457.
31. Zhu G., Xue J., Zhang H., **Z. Liu**, Zhuang S., and Dong P., 2008: Direct Assimilation of satellite radiance data in GRAPES variational assimilation system. China Science Bulletin, No. 22, Vol. 53, 3465-3469.
32. **Liu Z.** and Rabier, F., 2003: Potential of high density observations on Numerical Weather Prediction: A study with simulated observations. *Q. J. R. Meteorol. Soc.,* 129, 3013-3035.
33. **Liu Z.** and Rabier, F., 2002: The interaction between model resolution, observation resolution and observation density in data assimilation: A one-dimensional study. *Q. J. R. Meteorol. Soc., 128*, 1367-1386.

PEER-REVIEWED PUBLICATIONS: AIR-QUALITY RELATED

34. Sun, W., **Z. Liu**, Chen, D., Zhao, P., and Chen, M., 2020: Development and application of the WRFDA-Chem three-dimensional variational (3DVAR) system: aiming to improve air quality forecasting and diagnose model deficiencies, *Atmos. Chem. Phys.*, 20, 9311-9329.
35. Ha, S., **Z. Liu**, W. Sun, Y. Lee, and L. Chang, 2020: Improving air quality forecasting with the assimilation of GOCI AOD retrievals during the KORUS-AQ period, *Atmos. Chem. Phys.,* 20, 6015-6036.
36. Peng, Z., Lei, L., **Z. Liu**, Liu, H., Chu, K., & Kou, X. (2020). Impact of assimilating meteorological observations on source emissions estimate and chemical simulations. Geophysical Research Letters, 47, e2020GL089030. https://doi.org/10.1029/2020GL089030
37. Chen, D., **Z. Liu**, J. Ban, and M. Chen, 2019: 2015 and 2016 winter-time air pollution in China: SO2 emission changes derived from a WRF/Chem-EnKF coupled data assimilation system, *Atmos. Chem. Phys.,* **19**, 8619-8650.
38. Chen, D., **Z. Liu**, J. Ban, P. Zhao, and M. Chen, 2019: Retrospective analysis of 2015–2017 winter-time PM2.5 in China: response to emission regulations and the role of meteorology, *Atmos. Chem. Phys.,* **19**, 7409-7427.
39. Kumar, R., L. D. Monache, J. Bresch, P. E. Saide, Y. Tang, **Z. Liu**, A. M. da Silva, S. Alessandrini, G. Pfister, D. Edwards, and P. Lee, and I. Djalalova, 2019: Towards improving short-term predictions of fine particulate matter over the United States via assimilation of satellite aerosol optical depth retrievals, *J. Geophys. Res. Atmos.*, **124**, https://doi.org/10.1029/2018JD029009.

40. Pang, J., **Z. Liu**, X. Wang, J. Bresch, J. Ban, D. Chen, and J. Kim, 2018: Assimilating AOD retrievals from GOCI and VIIRS to forecast surface PM2.5 episodes over Eastern China. *Atmospheric Environment*, **179**, 288–304.
41. Peng, Z., L. Lei, **Z. Liu**, J. Sun, A. Ding, J. Ban, D. Chen, X. Kou, and K. Chu, 2018: The impact of multi-species surface chemical observations assimilation on the air quality forecasts in China, *Atmos. Chem. Phys.,* **18**, 17387–17404.
42. Chu, K., Z. Peng, **Z. Liu**, L. Lei, X. Kou, Y. Zhang, X. Bo, and J. Tian, 2018: Evaluating the Impact of Emissions Regulations on the Emissions Reduction during the 2015 China Victory Day Parade with an Ensemble Square Root Filter, *J. Geophys. Res. Atmos*., **123,** 4122-4134**.**
43. Chen, D., **Z. Liu**, Davis, C., and Gu, Y., 2017: Dust Radiative Effects on Atmospheric Thermodynamics and Tropical Cyclogenesis over the Atlantic Ocean Using WRF/Chem Coupled with an AOD Data Assimilation System, Atmos. Chem. Phys., 17, 7917-7939.
44. Peng, Z., **Z. Liu**, Chen, D., and Ban, J., 2017: Improving $PM_{2.5}$ forecast over China by the joint adjustment of initial conditions and source emissions with an ensemble Kalman filter, Atmos. Chem. Phys., 17, 4837-4855.
45. Chen, D., **Z. Liu**, Fast, J., and Ban, J., 2016: Simulations of sulfate–nitrate–ammonium (SNA) aerosols during the extreme haze events over northern China in October 2014, Atmos. Chem. Phys., 16, 10707-10724.
46. Chen, D., **Z. Liu**, Schwartz, C. S., H.-C. Lin, J. D. Cetola, Y. Gu, and L. Xue, 2014: The impact of aerosol optical depth assimilation on aerosol forecasts and radiative effects during a wild fire event over the United States. *Geosci. Model Dev.,* 7, 2709-2715.
47. Pagowski, M., **Liu, Z**., Grell, G. A., Hu, M., Lin, H.-C., and Schwartz, C. S., 2014: Implementation of aerosol assimilation in Gridpoint Statistical Interpolation (v. 3.2) and WRF-Chem (v.3.4.1), *Geosci. Model Dev.*, 7, 1621-1627.
48. Schwartz, C. S., **Z. Liu**, H.-C. Lin, and J.D. Cetola, 2014: Assimilating aerosol observations with a "hybrid" variational-ensemble data assimilation system. *J. Geophys. Res. Atmos.*, 119, 4043-4069.
49. Jiang, Z., **Z. Liu**, T. Wang, C. S. Schwartz, H.-C. Lin, and F. Jiang, 2013: Probing into the impact of 3DVAR assimilation of surface PM10 observations over China using process analysis. *J. Geophys. Res. Atmos.*, 118, 6738-6749.
50. Saide, P., G. Carmichael, **Z. Liu**, H.-C. Lin, C. S. Schwartz, A. Da Silva, and E. Hyer, 2013: Aerosol optical depth assimilation for a size-resolved sectional model: Impacts of empirically corrected, multi-wavelength and fine mode retrievals on regional scale forecasts. *Atmos. Chem. Phys.*, **13**, 10425-10444.
51. Schwartz, C. S., **Z. Liu**, H.-C. Lin, and S. McKeen, 2012: Simultaneous three-dimensional variational assimilation of surface fine particulate matter and MODIS aerosol optical depth. *J. Geophys. Res.*, **117**, D13202.
52. **Liu Z.,** Q. Liu, H.-C. Lin, C. S. Schwartz, Y.-H. Lee, ND T. Wang, 2011: Three-dimensional variational assimilation of MODIS aerosol optical depth: Implementation and application to a dust storm over East Asia. *J. Geophys. Res*., 116, D23206.

SELECTED PRESENTATIONS (PAST 5 YEARS)

1. **Progress of Data Assimilation for the Model for Prediction Across Scales (MPAS) within the Joint Effort for Data assimilation Integration (JEDI)**. 101st AMS (Virtual) Meeting, January 10-15, 2021.
2. **Multi-Resolution Incremental 4DVar for WRF: Implementation and Applications at convective scale**. 101st AMS (Virtual) Meeting, January 10-15, 2021.
3. **Impact of dropsonde and satellite radiance data assimilation derived from OSEs and adjoint-sensitivity tool for two AR events in 2019**. Atmospheric River Recon (Virtual) Workshop 2020, June 29 – July 1, 2020.
4. **WRFDA 2020 Update**, 2020 WRF/MPAS Users' (Virtual) Workshop, June 8-9, 2020.
5. **Chemical data assimilation: tool for better air quality prediction and decision making**, NCAR/MMM seminar, NCAR, Boulder, CO, January 8, 2020.
6. **Improving forecasts of the record-breaking Guangzhou "57" rainstorm by assimilating every 10-min AHI radiances with WRF 4DVAR**, 16th AOGS annual meeting, Singapore, July 30, 2019. [**Invited**]
7. **WRFDA 2019 Update,** 2019 Joint WRF/MPAS Users' Workshop, NCAR, Boulder, June 11, 2019.
8. **Toward a Cloud Analysis and Forecasting System Leveraging JEDI**, 17th JCSDA Science and Technical Workshop, Washington, D.C., May 30, 2019.
9. **WRF Convective Scale DA: Recent Work on Radar and Geostationary satellite DA**, 1st UM Convective-Scale Data Assimilation Workshop, Wellington, New Zealand, March 4, 2019. [**Invited**]
10. **Assimilation of clear- and all-sky Himawari-AHI Radiances for convective-scale forecasting**, 99th AMS Annual Meeting, Phoenix, January 7, 2019.
11. **A new radar reflectivity operator and its TL/AD for variational data assimilation**, Seminar at the Central Weather Bureau, Taipei, December 3, 2018. [**Invited**]
12. **Adaptive emission estimation over China with an EnKF and hourly surface PM2.5 observations**, 9th International Workshop on Air Quality Forecasting Research, Boulder, October 7, 2018.
13. **Added Value of Assimilating Himawari8-AHI Water Vapor Radiances on Analyses and Forecasts for Beijing "7.19" Severe Storm**, 15th AOGS annual meeting, Honolulu, June 7, 2018.
14. **Recent advancements of satellite radiance data assimilation in WRFDA**, the ISSI-BJ/ISSI Joint Workshop on Tropical and Subtropical Cyclones with Improved Satellite Observations, Beijing, China, May 10, 2018. [**Invited**]
15. **Atmospheric Constituents Initial Condition Analysis and Source Emission Inversion using Advanced Data Assimilation Techniques**, Annual meeting of Korean Society for Atmospheric Environment, Dongdaegu, Korea, November 10, 2017. [**Invited**]
16. **Assimilating Geostationary Satellite Imager Radiance Data for Improving Convection-Permitting Weather Forecast**, NCAS-NCAR WRF workshop, Durham, UK, October 13, 2017.

17. **WRF convective-scale data assimilation: progress and plan**, Seminar at the Chinese Academy of Meteorological Sciences of CMA, Beijing, August 31, 2018. [**Invited**]
18. **Impact of Assimilating GOES-Imager Radiance with A Rapid Refresh Assimilation System for Convection-Permitting Forecast over Mexico**, 18th Annual WRF Users' Workshop, NCAR, Boulder, June 15, 2017.
19. **Recent advancement of WRF Data Assimilation**, Seminar at KIAPS, Seoul, Korea, Feb. 30, 2017. [**Invited**]
20. **Advanced data assimilation for weather and air-quality prediction**, Seminar at the Yonsei University, Seoul, Korea, Feb. 24, 2017. [**Invited**]
21. **AMSR2 all-sky radiance assimilation and its impact on the analysis and forecast of Hurricane Sandy with WRFDA**, 97th AMS Annual Meeting, Seattle, January 26, 2017.
22. **Overview of WRFDA**, Workshop on "**Blueprints for Next-Generation Data Assimilation Systems",** NCAR, Boulder, March 8, 2016.
23. **Multi-Resolution Incremental 4DVAR: Formulation and Implementation**, Seminar at Central Taiwan Bureau (CWB), Taipei, November 23, 2015. [**Invited**]