SHU-CHIH YANG

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Education

08/2001-05/2005	**University of Maryland**, U.S.A, Ph.D in Meteorology, Department of Meteorology, *Dissertation title: "Bred vectors in the NASA NSIPP global coupled model and their application to coupled ensemble predictions and data assimilation."* Advisor: Prof. Eugenia Kalnay
09/1997-06/1999	**National Central University**, Taiwan, M.S. degree, Institute of Atmospheric Physics, *Dissertation title: "The application of NOAA Microwave-Sounding unit data to estimate the intensity of the typhoon."* Advisor: Professor Liu, Gin-Rong
09/1993-06/1997	**National Central University**, Taiwan, B.S. degree Department of Atmospheric Science

Professional Experience

Aug 2019-present	Professor	Department of Atmospheric Sciences, National Central University, Taiwan
Aug 2013-present	Visiting Scientist	RIKEN advanced institute for computational science, data assimilation team, Japan
Aug 2012-present	Associate Professor	Department of Atmospheric Sciences, National Central University, Taiwan
July 2008-Jul 2012	Assistant Professor	Department of Atmospheric Sciences, National Central University, Taiwan

Sep 2005- May 2008	Post-doctorial Research Associate	Global Modeling and Assimilation Office, NASA/GSFC and University of Maryland, U.S.A

> ➢ Implement the coupled breeding method for ensemble forecasting system of NASA coupled GCM
>
> ➢ Investigate the impact of bred vectors in ensemble ENSO prediction and its application in ocean data assimilation
>
> ➢ Advance applications of the Ensemble Kalman Filter

2002-2005	Research assistant	Department of Meteorology/ The Institute for Physical Science and Technology, University of Maryland

> ➢ Examine the characteristic of ENSO-related bred vectors derived from the independently developed CGCMs
>
> ➢ Investigate the implications of bred vectors and singular vectors for the ensemble-based and variational-based data assimilation methods

1999-2001	Software engineer	Institute of space science, National Central University, ROCSAT-1 IPEI Laboratory of Science Data Distribution Center

Software program development of ROCSAT1-IPEI data processing and cross-check the data validity

Awards/Honors received

- President Luo Jia-Lun (羅家倫校長) young outstanding research award, 2018 (3 receivers in NCU)
- Academia Sinica research award for junior research investigator, 2015
- Outstanding young research award in National Central University, 2014-2016
- Outstanding teaching award of College of Earth Science in National Central University, 2014
- Outstanding research award in National Central University, 2012-2016, 2018-2021
- Young outstanding women in Science, 2013 (2 receivers nationwide)
- The Da-You Wu award, National Science Council, 2012

- Outstanding new faculty in National Central University, 2009-2011
- Outstanding performance Award from NASA/GSFC GMAO, 2007
- Scholarship of government sponsorship for overseas study, Ministry of Education, Taiwan 2001

- **Invited speeches (2017 to present):**
  - Impact of Assimilating the GNSS-Reflectometry Sea Surface Wind on Severe Weather Prediction the Sasaki symposium, *the 19th annual meeting of Asia Oceania Geosciences Society*, 2022
  - Improving the Afternoon Thunderstorm Prediction with Assimilation of the GNSS-ZTD Data in Taiwan: a Case Study on 22 July 2019, the Sasaki symposium, *the 18th annual meeting of Asia Oceania Geosciences Society*, 2021
  - Including observation error correlation for assimilating radar radial wind and its impact on heavy rainfall prediction, *Dept. of Atmospheric Sciences, University of Hawaii at Manoa*, 10th Mar, 2021 (virtual)
  - Recent progress of the regional ensemble data assimilation system for severe weather prediction in Taiwan, *RIKEN, Japan*, 1st Oct, 2020 (virtual)
  - Recent development of the regional ensemble data assimilation system for high-impact weather prediction in Taiwan, *Academia Sinica*, 4th July 2020
  - Recent development of the regional ensemble data assimilation system for high-impact weather prediction in Taiwan, *RIKEN, Japan*, 10th Sep, 2019
  - Recent development of the ensemble radar data assimilation system for heavy prediction in Taiwan, *Kyoto University,* 6th Sep, 2019
  - From Chaos to Predictability: applying data assimilation to improve severe weather prediction in Taiwan, the NCU distinguish lecture, 2019
  - Impact of regional moisture analysis on heavy precipitation prediction in Taiwan, 2017 KIAPS international workshop on Real-Time NWP Forecast System, Jeju, South Korea.

Roles/positions and services

- Journal editors:
  - Topical editor of Geophysical model development (July 2022-present)
  - Editor of Scientific Online Letters on the Atmosphere (2015-present)
  - Guest editor of "A FORMOSAT-7/COSMIC-2 Special issue after 10year on orbit, Terrestrial, Atmospheric and Oceanic Science (2021-2022)
- Team leader of Software Analysis and application of Taiwan Space Union

- Review panel of discipline of atmospheric science, MOST (2018-2020)
- <u>Supervisors</u> of MS (16 graduated, 6 currently enrolled) and Ph.D students (4 graduated, 4 currently enrolled)
- <u>Referee of Journals</u>: Monthly Weather Review, Journal of Atmospheric Science, Journal of the Meteorological Society of Japan, Weather and Forecasting, IEEE Transactions of Geoscience and Remote Sensing, Advances in Atmospheric Sciences, Journal of Advances in Modeling Earth Systems, Terrestrial, Atmospheric and Oceanic Science, Scientific Online Letters on the Atmosphere, Journal of Meteorological Research, Tellus A, Nonlinear Processes in Geophysics, Quarterly journal of the Royal Meteorological Society, Journal of Atmospheric and Oceanic Technology, Journal of geophysical research Atmosphere, Asia-Pacific Journal of Atmospheric Sciences, Frontier, Atmospheric Research, Atmosphere-Ocean, Remote sensing, 大氣科學.
- <u>International conference conveners/committee</u>:
  - Session of "From Weather Predictability to Controllability", the 19th AOGS
  - Science committee member of International Symposium of Data Assimilation (2017, 2019)
  - Science Committee member of the Ensemble Kalman Filter workshop (2018)

Publication List

(a) Referred papers

1. Lin, K-J, **S-C Yang***, S. Chen, 2022: Improving Analysis and Prediction of Tropical Cyclones by Assimilating Radar and GNSS-R Wind Observations: Observing System Simulation Experiments, *Wea. Forecasting* (in press).

2. Chang, C-C, **S-C Yang***, and S. Penny, 2022: A regional hybrid gain data assimilation system and preliminary evaluation based on Radio Occultation reflectivity assimilation, SOLA, **18**, 33-40. https://doi.org/10.2151/sola.2022-006.

3. **Yang, S-C**, F-Y Cheng, L-J Wang, S-H Wang and C-H Hsu[,]: 2022: Impact of lidar data assimilation on planetary boundary layer wind and $PM_{2.5}$ prediction in Taiwan, *Atmospheric Environment, 277, 119064*.

4. Chang, C-C and **S-C Yang***, 2022: Impact of assimilating the Formosat-7/COSMIC-II GNSS Radio Occultation data on predicting the heavy rainfall event in Taiwan on 13 August 2019. Terrestrial, Atmospheric and Oceanic Sciences Journal, Exploring the terrestrial and space weather using an operational radio occultation satellite constellation -

A FORMOSAT-7/COSMIC-2 Special Issue after 1-year on orbit, TAO, **33**, 7, https://doi.org/10.1007/s44195-022-00004-4

5. Yeh, H-L, **S-C Yang***, K. Terasaki, T. Miyoshi, and Y-C Liou, 2022: Including observation error correlation for ensemble radar radial wind assimilation and its impact on heavy rainfall prediction**,** *Quart. J. Roy. Meteor. Soc.,* (in press), https://doi.org/10.1002/qj.4302

6. Lupo, K., R. Torn, and **S-C Yang**, 2022: Process-Based Evaluation of Stochastic Perturbed Microphysics Parameterization Tendencies on Ensemble Forecasts of Heavy Rainfall Events, *Mon. Wea. Rev.*, **150**, 175-191.

7. Chen, C.-H., K.-S. Chung, **S.-C. Yang**, L.-H. Chen, P.-L. Lin, R. D. Torn, 2021: Sensitivity of forecast uncertainty to different microphysics schemes within a convection-allowing ensemble during SoWMEX-IOP8. *Mon. Wea. Rev.*, 149, 4145–4166.

8. Lin, Z-H, **S-C Yang*** and E. Kalnay, 2021: An Ensemble Transform Kalman Incremental Smoother and its application to Data Assimilation and Prediction, *Front. Appl. Math. Stat.* 7:687743. doi: 10.3389/fams.2021.687743.

9. Wu, P-Y, **S-C Yang***, C-C Tsai and H-W Cheng, 2020: convective-scale sampling error and its impact on the ensemble radar data assimilation system: a case study of heavy rainfall event on 16th June 2008 in Taiwan. *Mon. Wea. Rev.*, **148**, 3631-3652.

10. Cheng, H-W, **S-C Yang***, C-S Chen and Y-C Liou, 2020: An investigation of the sensitivity of a WRF-based convective-scale assimilation system on an afternoon thunderstorm in northern Taiwan, *SOLA*, **16**, 97–103, https://doi.org/10.2151/sola.2020-017.

11. Chang, C-C, S. Penny and **S-C Yang**, 2020: Hybrid gain data assimilation using variational corrections in the subspace orthogonal to the ensemble, *Mon. Wea. Rev.*, **148**, 2331-2350.

12. Lupo, K., R. Torn and **S-C Yang**, 2020: Evaluation of Stochastic Perturbed Parameterization Tendencies on Convective-Permitting Ensemble Forecasts of Heavy Rainfall Events in New York and Taiwan, *Wea. Forecasting*. **35**, 5-24.

13. Chang, Y-P, **S-C Yang***, K-J Lin, G-Y Lien and C-M Wu, 2020: Impact of tropical cyclone Initialization on its convection development and intensity: A case study of Typhoon Megi (2010), *J. Atmos. Sci.*, **77**, 443-464., DOI: 10.1175/JAS-D-19-0058.1.

14. **Yang, S-C***, T-M Huang, C-Y Huang and C-C Tsai, 2019: Convective-scale assimilation with the GPS-ZTD and radar data and its impact on heavy rainfall prediction in Taiwan, *Mon. Wea. Rev.*, **148**, 1075-1098.

15. Chen, S-H, **S-C Yang***, C-Y Chen, C. P. van Dam, A. Cooperman, H. Shiu, C. MacDonald, J. Zack, 2019:   Application of Bias Corrections to Improve Hub-height Ensemble Wind Forecasts over the Tehachapi Wind Resource Area, *Renewable Energy*, **140**, 281-291.

16. Shin, S., J-S Kang, **S-C Yang** and E. Kalnay, 2019: Ensemble singular vectors as additive inflation in the Local Ensemble Transform Kalman Filter (LETKF) framework with a global NWP model, *Quart. J. Roy. Meteor. Soc.*, **145**, 258-272, https://doi.org/10.1002/qj.3429

17. Lin, K-J, **S-C Yang*** and S. S. Chen, 2018: Reducing TC position uncertainty in an ensemble data assimilation and prediction system: A Case Study of Typhoon Fanapi (2010), *Wea. Forecasting.*, **33**, 561-582.

18. **Yang, S-C**, S-H Chen, K. Kondo, T. Miyoshi, Y-C Liou, Y-L Deng, and H-L Chang, 2017: Multilocalization data assimilation for predicting heavy precipitation associated with a multiscale weather system. *Journal of Advances in Modeling Earth Systems*, **9**, doi:10.1002/2017MS00100.

19. Tseng, Y-H, Y-H Lin, M-H Lo and **S.-C. Yang**, 2016: Diagnosing the dynamics controlling Sahel precipitation in the short-range ensemble community atmospheric model hindcasts. *Clim. Dym*. 1-18, doi:10.1007/s00382-016-2995-9.

20. **Yang***, **S-C**, E. Kalnay and T. Enomoto, 2015: Ensemble Singular Vectors and their use as additive inflation in EnKF, *Tellus A*, 67, 26536.

21. Chang, H.-L., S.-C. Yang*, H. Yuang, P-L Lin and Y-C Liou, 2015: Analysis of the relative operating characteristic and economic value using the LAPS ensemble prediction system in Taiwan. *Mon. Wea. Rev*., 140, 1496-1516.

22. Chang, C.-C., **S.-C. Yang*** and C. Keppenne, 2014: Applications of the mean re-recentering scheme to improve typhoon track prediction: A case study of typhoon Nanmadol (2011), *JMSJ special edition on AICS-DA workshop*, **92**, 559-584.

23. **Yang***, **S.-C.**, S.-H. Chen, S.-Y. Chen, C.-Y. Huang and C.-S. Chen, 2014: Evaluating the impact of the COSMIC-RO bending angle data on predicting the heavy precipitation episode on 16 June 2008 during SoWMEX-IOP8. *Mon. Wea. Rev.*, **142**, 4139-4163.

24. Tsai, C.-C., **S.-C. Yang***, and Y.-C. Liou, 2014: Improving Short-Term QPFs with a WRF-LETKF Radar Data assimilation system: OSSEs on Typhoon Morakot (2009). *Tellus A*, **66**, 21804.

25. Huang, Z-K, Z. Peng, H-N Liu, M-G Zhang, X-G Ma, **S-C Yang**, S-D Lee, and S-Y Kim, 2014: Development of CMAQ for East Asia CO_2 data assimilation under an EnKF framework: a first result. *Chinese Science Bulletin*, 10.1007/s11434-014 -0348-9.

26. **Yang*, S.-C.,** K.-J. Lin, T. Miyoshi and E. Kalnay, 2013: Improving the spin-up of regional EnKF for typhoon assimilation and forecasting with Typhoon Sinlaku (2008). *Tellus A,* **65**, 25804.

27. **Yang*, S-C**, E. Kalnay and T. Miyohsi, 2012: Improve EnKF spin-up for typhoon assimilation and prediction, *Wea. Forecating*. **27**, 878-897.

28. Norwood, A., E. Kalnay, K. Ide, **S-C Yang**, and C. Wolfe, 2013: Lyapunov, singular and bred vectors in a multi-scale system: an empirical exploration of vectors related to instabilities. *Journal of Physics A, special issue of Lyapunov vectors*, in press.

29. Ham, Y-G, M. M. Rienecker, S. Schubert, J. Marshak, S-W Yeh, and **S.-C. Yang**, 2012:

30. The Decadal Modulation of Coupled Bred Vectors for Seasonal Forecasts. Geophys. Res. Lett., **39**, 20712.

31. **Yang*, S-C**, E. Kalnay and B. Hunt, 2012: Handling nonlinearity and non-Gaussianity in Ensemble Kalman Filter. ", *Mon. Wea. Rev*. Special collection "Intercomparisons of 4D-Variational Assimilation and the Ensemble Kalman Filter. **140**, 2628-2646.

32. **Yang*, S-C**, M. Rienecker, C. Keppenne, 2010: Impact on the seasonal-to -interannual forecasting from the ocean data assimilation: A case study of 2006 El Nino event. *J. of Climte*, **23**, 4080-4095.

33. Kalnay, E. and **S-C Yang**, 2010: Accelerating the spin up of Ensemble Kalman Filtering, *Q. J. R. Meteorol. Soc.*, **136,** 1644-1651.

34. **Yang*, S-C**, E. Kalnay, B. Hunt, N. Bowler, 2009: Weight interpolation for efficient data assimilation with the Local Ensemble Transform Kalman Filter. *Quar. Quart. J. Roy. Meteor. Soc.*, 135, 251-262. 2009.

35. **Yang*, S-C**, C. Keppenne, M. Rienecker, E. Kalnay, 2009: Applications of coupled bred vectors to seasonal-to-interannual forecasting and ocean data assimilation. *J. Climate*, **22**, 2850-2870.

36. Ballabrera-Poy, J., E. Kalnay and **S-C Yang**, 2009: Data assimilation in a system with two scales. Combining two data assimilation techniques. *Tellus*, 61A, 539-549.

37. Hoffman, M. J., E. Kalnay, J. Carton, and **S-C Yang**, 2009: Use of breeding to detect and explain instabilities in the global ocean. Geophys. Res. Lett., 36, L12608. 2009

38. **Yang*, S-C**, M. Corazza, A. Carrassi, E. Kalnay, and T. Miyoshi, 2008: Comparison of ensemble-based and variational-based data assimilation schemes in a quasi-geostrophic model. *Mov. Wea. Rev.,* 137, 693-709.

39. **Yang*, S-C**, E. Kalnay, M. Cai and M. Rienecker, 2008: Bred vectors and tropical Pacific forecast errors in the NASA coupled general circulation model. *Mon. Wea. Rev.* **136**, 1305-1326.

40. Kalnay, E., H. Li, T. Miyoshi, **S-C Yang** and J. Ballabrera-Poy, 2007: 4D-Var or Ensemble Kalman Filter? *Tellus-A*, **59**, 758-773, 2007

41. Kalnay, E., H. Li, T. Miyoshi, **S-C Yang** and J. Ballabrera-Poy, 2007: Resphonse to the discussion on 4D-Var or Ensemble Kalman Filter? By Nils Gustafsson. *Tellus-A*, **59**, 778-780.

42. Corazza, M., E. Kalnay and **S-C Yang**, 2007: An implementation of the Local Ensemble Kalman Filter for a simple quasi-geostrophic model: Results and comparison with a 3D-Var data assimilation system. *Nonlinear Processes in Geophysics*, **14**, 89-101.

43. **Yang, S-C**, D. Baker, H. Li, M. Huff, G. Nagpal, E. Okereke, J. Villafane, E. Kalnay and G. Duane, 2006: Data assimilation as synchronization of truth and model: experiments with the 3-variable Lorenz system. *J. Atmos. Sci.*, **63**, 2340-2354.

44. **Yang, S-C**, M. Cai, E. Kalnay, M. Rienecker, G. Yuan and Z. Toth, 2006: ENSO Bred Vectors in Coupled Ocean-Atmosphere General Circulation Models. *J. Climate*, **19**, 1422-1436.

45. Evans, E., N. Bhatti, J. Kinney, L. Pann, M. Pena, **S-C Yang**, E. Kalnay and J. Hansen, 2004: RISE: Undergraduates Find That Regime Changes in Lorenz's Model are Predictable. *Bull. Amer. Meteor. Soc.*, **85**, 520-524.

46. Corazza, M., E. Kalnay, D. J. Patil, **S-C Yang**, R. Morss, M. Cai, I. Szunyogh, B. R. Hunt, and J. A. Yorke, 2003: Use of the breeding technique to estimate the structure of the analysis "error of the day". *Nonlinear Processes in Geophysics*, **10**, 233-243.

(b) Book Chapter:

Yang S.-C., 2022: Convective-Scale Data Assimilation and Precipitation Prediction with a Local Ensemble Transform Kalman Filter Radar Assimilation System Over Complex Terrain: A Thorough Investigation with the Heavy Rainfall in Taiwan on 16 June 2008, Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications (Vol. IV), ISBN: 978-3-030-77721-0, Springer.