

## Research Interests

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- Aerosol-cloud interactions, cloud feedbacks, boundary layer cloud dynamics, cloud-circulation coupling, Earth's energy budget, hemispheric albedo symmetry, climate intervention, marine cloud brightening

## Research Appointments

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- **Postdoctoral Research Associate** New York, NY  
*University of Colorado, Boulder* *May 2025 – Present*
  - Studying interactions between sea ice and Arctic mixed-phase clouds with CESM2.
  - Using a hierarchy of idealized perturbation experiments to understand the efficacy of marine cloud brightening and mixed-phase cloud thinning on Arctic sea ice.
  - Supervisors: Dr. Andrew Gettelman and Dr. Marika Holland
- **Research Physical Scientist (Federal civil servant)** Princeton, NJ  
*NOAA Geophysical Fluid Dynamics Laboratory* *October 2024 - April 2025*
  - Led development of aerosol-cloud interactions scheme in GFDL's AM5, including updates to couple new 2-moment aerosol physics with new 2-moment cloud physics, with focus on applications for marine cloud brightening experiments.
  - Led research constraining and understanding historical aerosol radiative forcing, especially  $ERF_{aci}$ .
  - Developed a Lagrangian microphysics model analog for Princeton Cloud Chamber to investigate homogeneous nucleation of liquid droplets.
  - Supervisor: Dr. David Paynter
- **NOAA C&GC Postdoctoral Fellow** Palisades, NY  
*Columbia University, Lamont-Doherty Earth Observatory* *October 2023 - October 2024*
  - Used satellite and reanalyses to investigate 21st century clear-sky brightening trends over the Southern Ocean.
  - Developed CESM mock-Walker aquaplanet configuration to study low cloud feedback dependence on mean-state zonal atmospheric overturning circulation strength.
  - Host: Dr. Robert Pincus

## Education

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- **California Institute of Technology** Pasadena, CA  
*MS/PhD Department of Environmental Science and Engineering* *October 2018 - August 2023*
  - Research advisor: Dr. Tapio Schneider
  - Thesis: “The role of small-scale cloud, aerosol, and radiation processes for Earth's climate”
- **University of Chicago** Chicago, IL  
*BA Physics, BS Mathematics* *September 2014 - June 2018*
  - Research Advisor: Dr. Liz Moyer
  - Undergraduate thesis: “Comparison of water vapor observations in the Asian Monsoon UTLS region”

## Publications

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(\* = student advisee, † = equal contributions)

1. **C.E. Singer** and R. Pincus, “Southern Ocean clear-sky brightening caused by wind-driven sea spray aerosol increase.” *Geophysical Research Letters*, In review. doi:10.22541/essoar.175987728.89680304/v1.

2. **C.E. Singer**, S. Arabas, and R.X. Ward, “Using laboratory data to inform superdroplet representations of surface-active organics in cloud droplet activation.” *Atmospheric Chemistry and Physics*, In prep.
3. K. Lamb, **C.E. Singer**, K. Loftus, H. Morrison, M. Powell, J. Ko, J. Buch, M. van Lier Walqui, and P. Gentine, “Perspectives on Systematic Cloud Microphysics Scheme Development with Machine Learning.” *Journal of Advances in Modeling Earth Systems*, In review. doi:10.22541/essoar.175244548.89034582/v1.
4. **C.E. Singer**, J. Guan\*, N. Neumann, P. Alexander, B. Medeiros, Q. Zhu, A.M. Fiore, R. Pincus, “Climate sensitivity and cloud feedback dependence on scale and strength of mean-state Walker circulation.” In prep.
5. Q. Zhu, N. Neumann, A.M. Fiore, R. Pincus, J. Guan, G. Milly, **C.E. Singer**, B. Medeiros, and P. Giani, “Uncertain Natural Emissions Modulate the Response of Hydroxyl Radical (OH) to Idealized Surface Warming.” *Journal of Advances in Modeling Earth Systems*, In review.
6. **C.E. Singer** and T. Schneider. “A conceptual model for the stratocumulus-cumulus transition.” *Journal of Advances in Modeling Earth Systems*, In review. doi:10.22541/essoar.168167352.24863390/v1.
7. **C.E. Singer** and T. Schneider. “A conceptual model of CO<sub>2</sub>-driven stratocumulus cloud breakup.” *Journal of Advances in Modeling Earth Systems*, In review. doi:10.22541/essoar.168167204.45220772/v1.
8. M. Liu-Schiaffini\*, **C.E. Singer**, N. Kovachki, T. Schneider, K. Azizzadenesheli, and A. Anandkumar, “Tipping Point Forecasting in Non-Stationary Dynamics on Function Spaces.” *Proceedings of the National Academy of Sciences*. In prep. doi:10.48550/arXiv.2308.08794.
9. B.W. Clouser, C.C. KleinStern, A. Desmoulin, **C.E. Singer**, J. St. Clair, T.F. Hanisco, D.S. Sayres, and E.J. Moyer, “A systematic comparison of ACE-FTS  $\delta$ D retrievals with airborne in situ sampling.” *Atmospheric Measurement Techniques Discussions*. doi:10.5194/egusphere-2025-1190.
10. B.W. Clouser, L.C. Sarkozy, **C.E. Singer**, C.K. KleinStern, A. Desmoulin, D. Gaeta, S. Khaykin, S. Gabbard, S. Shertz, and E.J. Moyer, “The Airborne Chicago Water Isotope Spectrometer: An Integrated Cavity Output Spectrometer for Measurements of the HDO/H<sub>2</sub>O Isotopic Ratio in the Asian Summer Monsoon.” *Atmospheric Measurement Techniques*. doi:10.5194/amt-2024-98.
11. L.A. Dove, **C.E. Singer**, S.E. Murphy. “Ten steps to make qualifying examinations in geoscience graduate programs more equitable.” *AGU Advances*, 5, e2024AV001260, 2024. doi:10.1029/2024AV001260.
12. G. Feingold, et al. “Community consensus on physical science research needs to evaluate the viability of marine cloud brightening” *Science Advances*, 10(12), eadi8594, 2024. doi:10.1126/sciadv.adi8594.
13. E.K. de Jong<sup>†</sup>, **C.E. Singer**<sup>†</sup>, S. Azimi, O. Bulenok, P. Bartman, K. Derlatka, I. Dula, A. Jaruga, J.B. Mackay, R.X. Ward, and S. Arabas, “PySDM v2: collisional breakup, immersion freezing, dry aerosol initialization, and adaptive time-stepping.” *Journal of Open Source Software*, 8(84), 4968, 2023. doi:10.21105/joss.04968.
14. K.A. Schiro, H. Sui, F. Ahmed, N. Dai, **C.E. Singer**, P. Gentine, G.S. Elsaesser, J.H. Jiang, Y.-S. Choi, and J.D. Neelin, “Model spread in tropical low cloud feedback tied to overturning circulation response to warming.” *Nature Communications*, 13, 7119, 2022. doi:10.1038/s41467-022-34787-4.
15. P. Bartman, O. Bulenok, K. Grski, A. Jaruga, G. Lazarski, M.A. Olesik, B. Piasecki, **C.E. Singer**, A. Talar, and S. Arabas, “PySDM v1: particle-based cloud modeling package for warm-rain microphysics and aqueous chemistry.” *Journal of Open Source Software*, 7(72), 3219, 2022. doi:10.21105/joss.03219.
16. **C.E. Singer**, B.W. Clouser, S.M. Khaykin, M. Krmer, F. Cairo, T. Peter, A. Lykov, C. Rolf, N. Spelten, A. Afchine, S. Brunamonti, and E.J. Moyer, “Intercomparison of UTLS water vapor measurements over the Asian Summer Monsoon.” *Atmospheric Measurement Techniques*, 15, 4767-4783, 2022. doi:10.5194/amt-15-4767-2022.
17. S.M. Khaykin, E.J. Moyer, M. Krmer, B. Clouser, S. Bucci, B. Legras, A. Lykov, A. Afchine, F. Cairo, I. Formanyuk, V. Mitev, R. Matthey, C. Rolf, **C.E. Singer**, N. Spelten, V. Volkov, V. Yushkov, and F. Stroh, “Persistence of moist plumes from overshooting convection in the Asian monsoon anticyclone.” *Atmospheric Chemistry and Physics*, 22, 3169-3189, 2022. doi:10.5194/acp-22-3169-2022.

18. **C.E. Singer**, I. Lopez-Gomez, X. Zhang, T. Schneider, “Top-of-atmosphere albedo bias from neglecting three-dimensional cloud radiative effects.” *Journal of Atmospheric Science*, 78(12), 4053-4069, 2021. doi:10.1175/JAS-D-21-0032.1.
19. Y. Ming, N.G. Loeb, P. Lin, Z. Shen, V. Naik, **C.E. Singer**, R.X. Ward, F. Paulot, Z. Zhang, N. Bellouin, L.W. Horowitz, P.A. Ginoux, and V. Ramaswamy, “Assessing the influence of COVID19 on the shortwave radiative fluxes over the East Asian Marginal Seas.” *Geophysical Research Letters*, e2020GL091699, 2020. doi:10.1029/2020GL091699.
20. R. Bernstein, **C.E. Singer**, S.P. Singh, C. Mao, and C.J. Arnusch, “UV initiated surface grafting on polyethersulfone ultrafiltration membranes via ink-jet printing assisted modification.” *Journal of Membrane Science*, 548 (2018). doi:10.1016/j.memsci.2017.10.069.
21. K.A. Murphy, N. Reiser, D. Chosky, **C.E. Singer**, and H.M. Jaeger, “Freestanding loadbearing structures with Z-shaped particles.” *Granular Matter*, 18, 26 (2016). doi:10.1007/s10035-015-0600-2.

## Invited Presentations

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1. AGU Fall Meeting, Session A063. Dec 2025.
2. Gordon Research Conference on Radiation and Climate. Jul 2025.
3. Princeton AOS Atmospheric Dynamics Seminar. Nov 2024.
4. NOAA C&GC Summer Institute. Jul 2024.
5. University of Mainz Seminar on Mathematics and Atmospheric Physics. May 2024.
6. NYU Courant Atmosphere and Ocean Science Seminar. Apr 2024.
7. Yale Department of Earth and Planetary Sciences Colloquium. Feb 2024.
8. UIUC Department of Atmospheric Science Seminar. Jan 2024.
9. Florida State University Department of Meteorology Seminar. Dec 2023.
10. UIUC Department of Atmospheric Sciences Seminar. Nov 2023.
11. U Washington Department of Atmospheric Sciences seminar. Nov 2023.
12. JPL Center for Climate Sciences (CCS) Friday Seminar Series. Apr 2023.
13. UCSD Scripps Institute of Oceanography, Climate Journal Club. Mar 2023.
14. GFDL Atmospheric & Oceanic Sciences Seminar. Feb 2023.
15. NASA GISS Lunch Seminar. Feb 2023.

## Conference Presentations

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1. “Southern Ocean clear-sky brightening caused by wind-driven sea spray aerosol increase.” **Poster**. Gordon Research Seminar & Conference; Lewiston, ME; July 2025.
2. “Trends in hemispheric albedo symmetry: brightening of Southern Ocean clear-sky reflection driven by aerosol.” **Poster**. AGU 2024 Fall Meeting; Washington, D.C.; December 2024.
3. “Climate sensitivity and cloud feedback dependence on scale and strength of mean-state Walker circulation.” **Poster**. AGU 2024 Fall Meeting; Washington, D.C.; December 2024.
4. “Using laboratory data to inform superdroplet representations of surface-active organics.” **Poster**. Micro2Macro CLIVAR Workshop; Laramie, WY; October 2024.
5. “Earth’s Hemispheric Albedo Symmetry.” **Poster**. CFMIP; Boston, MA; June 2024.
6. “Exploring CO<sub>2</sub>-Induced Stratocumulus Cloud Breakup in CESM.” **Talk & Poster**. Gordon Research Seminar & Conference; Lewiston, ME; July 2023.

7. “Surface-Active Organics: Results from a Particle-Based Microphysics Model Calibrated with Laboratory Experiments.” **Talk.** AMS annual meeting; Denver, CO; January 2023.
8. “Stratocumulus cloud feedbacks in a simple physical model.” **Talk.** CalGFD; Pasadena, CA; August 2022.
9. “Extended mixed-layer theory for the stratocumulus-cumulus transition in climatology and under extreme CO<sub>2</sub> forcing.” **Talk.** CFMIP; Seattle, WA; July 2022.
10. “Successes, Challenges, and Lessons Learned by the Caltech URGE Pod.” **Poster.** AGU 2021 Fall Meeting; New Orleans, LA; December 2021.
11. “Analytical Theory for Stratocumulus Cloud Feedbacks.” **Talk.** AGU 2021 Fall Meeting; New Orleans, LA; December 2021.
12. “Quantifying Cloud Sensitivity to Aerosol Hygroscopicity using a Lagrangian Cloud Model.” **Virtual talk.** ICCP; August 2021.
13. “Top-of-atmosphere albedo bias from neglecting three-dimensional radiative transfer through clouds.” **Virtual poster.** AGU 2020 Fall Meeting; December 2020.
14. “Investigating Stratocumulus Cloud Sensitivity to Aerosol Hygroscopicity using a Lagrangian Particle-based Microphysics Model.” **Poster.** AGU 2019 Fall Meeting; San Francisco, CA; December 2019.
15. “A Conceptual Model of the Climate Change Response in Stratocumulus-Topped Boundary Layers.” **Poster.** AMS Conference on Atmospheric and Oceanic Fluid Dynamics; Portland, ME; June 2019.
16. “ChiWIS: The Chicago Water Isotope Spectrometer.” **Poster** Goldschmidt; Boston, MA; Aug 2018.
17. “Comparison of water vapor from observations and models in the Asian Monsoon UTLS region.” **Poster.** AGU 2017 Fall Meeting; New Orleans, LA; Dec 2017.

## Awards

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<i>Geophysical Research Letters</i> Outstanding Reviewer Award . . . . .	2023
NOAA Climate & Global Change Postdoctoral Fellowship . . . . .	2023-2025
3rd place, DRI’s Wagner Award for Women in Atmospheric Sciences (paper competition) . . . . .	2023
CalGFD Student Presentation Award . . . . .	2022
CFMIP Outstanding Early Career Presentation Award . . . . .	2022
Caltech ESE Department (inaugural) Service Award . . . . .	2021
Richard H. Jahns Teaching Award (Caltech GPS Division TA Award) . . . . .	2021
NSF Graduate Research Fellowship . . . . .	2018-2021
John Haeseler Lewis Prize (top UChicago graduating physics major) . . . . .	2018
Barry M. Goldwater Scholarship . . . . .	2017
Astronaut Scholarship . . . . .	2017
David W. Grainger Fellowship (full tuition for top UChicago physics rising senior) . . . . .	2017

## Teaching and Mentoring

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- **Teaching Assistant** Caltech  
*ESE 101 (Fall 2019), ESE 130 (Winter 2021), ESE 134 (Spring 2022)* 2019-2022
  - ESE 101 (Earth’s Atmosphere): I developed weekly quizzes, hosted office hours and recitation discussion sessions, and graded homework assignments.
  - ESE 130 (Atmosphere and Ocean Dynamics, an introductory GFD course): I hosted office hours, graded homework assignments, and created short videos for asynchronous learning.
  - ESE 134 (Cloud and Boundary Layer Dynamics): I wrote and graded homework assignments, hosted weekly office hours, prepared two 90-minute lectures on stratocumulus-topped boundary layers and cloud microphysics, and graded student final presentations and written reports. I am also co-authoring a textbook with Dr. Schneider on this topic and based on this course.
- **SURF mentor** Caltech  
*Summer Undergraduate Research Fellow program* Summer 2022

- I mentored a Caltech undergrad student in her first research experience through the SURF program.
- **Scientific project goals:** characterize subtropical humidity in present climate, how it changes under future emissions scenarios, and quantify the spread across the CMIP6 model ensemble.
- **Technical goals:** develop coding skills, learn how to work with large amounts of data on remote machines, gain familiarity with climate science concepts.

## Community Service & Outreach Activities

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- **Volunteer at the Climate Learning Lab** 2025–Present  
*American Museum of Natural History*
  - Volunteer educator at the AMNH Climate Learning Lab. Guide museum visitors through interactive exhibits to teach them about the atmosphere and climate.
- **Diversity, Equity, Inclusion, and Accessibility Committee** 2024–2025  
*NOAA GFDL*
  - Member of the (now disbanded) GFDL DEIAC. Contributed to GFDL 5-year review question on progress with DEIA at the lab. Participated in development of new recruiting tools for GFDL summer undergraduate research fellowship.
- **Caltech GPS URGE Pod** 2020–2023  
*Member (2020–2022) and Leader (2022)*
  - Participant and leader of the Caltech GPS’s Unlearning Racism in the Geoscience Pod. This group participated in the national curriculum for URGE in Jan-June 2020 reading primary literature on structural racism in the geosciences and developing action plans for our own department. From June 2020 until present our Pod has been enacting these plans – working with our division’s DEI committee, Academic Committee, Fieldwork Committee, and the Chair.
- **Caltech Women in GPS student group** 2018–2023  
*President (2021–2022); Vice President (2019–2021)*
  - Managed and oversaw club activities – including journal club discussions, workshops, and social events – communicates with faculty, and recruiting new members.
- **K-12 science outreach events** 2019–2023  
*Caltech CTLO Pasadena, CA*
  - Volunteered at various science nights and outreach events for local K-8 students talking about climate, clouds, and climate change with my homemade “albedo t-shirts” demonstration activity.
- **Caltech Title IX Student Leadership Team** 2019–2022  
*Giving Voice script writer (2019–2020); Title IX Council member (2019–2022)*
  - Provided resources and created awareness around Title IX topics for students, staff, and faculty.
- **UChicago Society of Women in Physics** 2014–2018  
*President (2017–2018), Vice President (2016–2017), Board Member (2016)*
  - Organized and coordinated logistics for events to foster a strong community among students in the physics department. Coordinated SWiPs mentorship program for first year students. Worked with professors and administrative staff to improve communication between undergraduates and faculty. Attended the Conference of Undergraduate Women in Physics (CUWiP) in January 2015 at the University of Michigan and January 2018 at the University of Iowa.

## Professional Service

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- **Journal reviewer** for *Nature*, *npj Climate and Atmospheric Science*, *Journal of Atmospheric Sciences*, *Journal of Climate*, *Geophysical Research Letters*, *Journal of Advances in Modeling Earth Systems*, *Journal of Geophysical Research: Atmospheres*, *Aerosol Science and Technology*, and *Atmospheric Chemistry and Physics*
- **Proposal reviewer** for DOE Atmospheric System Research, NSF Climate and Large-Scale Dynamics
- **Local organizer** of CFMIP annual meeting at Boston College (2024)
- **Convener and Chair** for AGU Fall Meeting session on “(A)symmetries in Earth’s Climate” (2024)

- **Discussion leader** at Gordon Research Seminar on Radiation and Climate (2025)
- **Organizer** of Caltech ESE Department Seminar (2019–2022)
- **Organizer** of Lamont OCP Seminar (2023–2024)
- **Member** of AGU Atmospheric Science Section Early Career Committee; Subcommittee on Resources for Early Career Scientists (2025–Present)