

Research Interests

- 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

- **Research Physical Scientist (Federal civil servant)** Princeton, NJ
NOAA Geophysical Fluid Dynamics Laboratory *October 2024 - April 2025; September 2026 - Present*
 - Leading 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.
 - Leading research constraining and understanding historical aerosol radiative forcing, especially ERF_{aci} , and regional contribution of aerosols to recent observed trends in Earth's Energy Imbalance (EEI).
 - Developing a Lagrangian microphysics model analog for Princeton Cloud Chamber to investigate homogeneous nucleation of liquid droplets.
 - Supervisor: Dr. David Paynter
- **Research Scientist II; Postdoctoral Research Associate** New York, NY
University of Colorado, Boulder *May 2025 - September 2026*
 - Studied surface radiative effects of sea ice and clouds in polar regions.
 - Used a hierarchy of idealized perturbation experiments with CESM2 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
- **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

- **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

(* = student advisee, † = equal contributions)

1. **C.E. Singer**, et al., "Efficacy of Arctic marine cloud brightening across seasons and surface cover." *Earth's Future*, Submitted.

2. W.R. Lee, C-C. Chen, **C.E. Singer**, et al., “Climate response to idealized Arctic marine cloud brightening across strategies and scales in CESM2.” *Earth’s Future*, Submitted.
3. **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.
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. S. Arabas, A. Zaba, D. Klimaszewska, E.C. Ware, **C.E. Singer**, M. Alhilali, J. Barr, D.G. Partridge, S. Shima, and R. Wood. “Exploring Cloud Microphysics Modeling Concepts the Pythonic Way.” *Geoscientific Model Development*, In discussion. doi:10.5194/egusphere-2026-3906.
6. **C.E. Singer**[†], O. Hadas[†], F. Bender, F. Glassmeier, R. Orlijan-Rhyne, and M. Schulz, “Dynamical regimes reveal drivers of Earths growing energy imbalance.” *Geophysical Research Letters*, In review. doi:10.22541/essoar.15005264/v1.
7. **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.
8. **C.E. Singer** and T. Schneider. “A conceptual model of CO₂-driven stratocumulus cloud breakup.” *Journal of Advances in Modeling Earth Systems*, In review. doi:10.22541/essoar.168167204.45220772/v1.
9. 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*. Accepted. doi:10.48550/arXiv.2308.08794.
10. B. Stevens, et al. (including **C.E. Singer**). “Earth’s net incoming energy-flux imbalance (and its implications for understanding climate change).” Workshop Report, 2026. doi:10.17617/2.3711842.
11. Q. Zhu, A. M. Fiore, R. Pincus, J. Guan, **C.E. Singer**, B. Medeiros, and P. Giani, “Weak OH response to idealized El Nino.” *Geophysical Research Letters*. 53, e2026GL122619, 2026. doi:10.1029/2026GL122619.
12. Q. Zhu, N. Neumann, A.M. Fiore, R. Pincus, J. Guan, G. Milly, **C.E. Singer**, B. Medeiros, and P. Giani, “Uncertain natural emissions dampen the increase in tropospheric hydroxyl radical (OH) with idealized surface warming.” *Journal of Advances in Modeling Earth Systems*, 18, e2025MS005248, 2026. doi:10.1029/2025MS005248.
13. **C.E. Singer** and R. Pincus, “Southern Ocean clear-sky brightening from sea spray aerosol increase drives departure from hemispheric albedo symmetry.” *Geophysical Research Letters*, 53, e2025GL119637, 2026. doi:10.1029/2025GL119637.
14. 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*, 18, e2025MS005341, 2026. doi:10.1029/2025MS005341.
15. 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 δ D retrievals with airborne in situ sampling.” *Atmospheric Measurement Techniques*. 19, 1147-1163, 2026. doi:10.5194/amt-19-1147-2026.
16. 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/H₂O Isotopic Ratio in the Asian Summer Monsoon.” *Atmospheric Measurement Techniques*. 18, 6465–6491, 2025. doi:10.5194/amt-2024-98.
17. 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.
18. 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.

19. E.K. de Jong[†], **C.E. Singer**[†], 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.
20. 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.
21. 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.
22. **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.
23. 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. Strohm, “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.
24. **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.
25. 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.
26. 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.
27. 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.

Open-source Software Contributions

1. Co-developer of PySDM
2. Main developer of Insolation.jl
3. Developer of MixedLayerModel.jl
4. Contributor to UWLCM
5. Contributor to libcloudph++
6. Contributor to libmpdata++

Invited Presentations

1. 2nd GEWEX Earth’s Energy Imbalance Assessment Workshop. June 2026.
2. CERES 44th Science Team Meeting. May 2026.
3. NASA GISS Lunch Seminar. Apr 2026.
4. Max Planck Institute for Meteorology Joint Seminar. Apr 2026.

5. Ringberg Workshop on Earth's Energy Imbalance. Mar 2026.
6. ECS & Cloud Feedback Virtual Symposium. Feb 2026.
7. Florida State University Department of Meteorology Seminar. Jan 2026.
8. Princeton AOS Atmospheric Dynamics Seminar. Nov 2024.
9. NOAA C&GC Summer Institute. Jul 2024.
10. University of Mainz Seminar on Mathematics and Atmospheric Physics. May 2024.
11. NYU Courant Atmosphere and Ocean Science Seminar. Apr 2024.
12. Yale Department of Earth and Planetary Sciences Colloquium. Feb 2024.
13. UIUC Department of Atmospheric Science Seminar. Jan 2024.
14. Florida State University Department of Meteorology Seminar. Dec 2023.
15. UIUC Department of Atmospheric Sciences Seminar. Nov 2023.
16. U Washington Department of Atmospheric Sciences seminar. Nov 2023.
17. JPL Center for Climate Sciences (CCS) Friday Seminar Series. Apr 2023.
18. UCSD Scripps Institute of Oceanography, Climate Journal Club. Mar 2023.
19. GFDL Atmospheric & Oceanic Sciences Seminar. Feb 2023.
20. NASA GISS Lunch Seminar. Feb 2023.

Conference Presentations

1. "Complex seasonality of Arctic mixed-phase cloud brightening/thinning." **Invited Talk.** AGU Fall Meeting, Session A063; New Orleans, LA; Dec 2025.
2. "Southern Ocean clear-sky brightening caused by wind-driven sea spray aerosol increase." **Invited Talk & Poster.** Gordon Research Seminar & Conference; Lewiston, ME; July 2025.
3. "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.
4. "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.
5. "Using laboratory data to inform superdroplet representations of surface-active organics." **Poster.** Micro2Macro CLIVAR Workshop; Laramie, WY; October 2024.
6. "Earth's Hemispheric Albedo Symmetry." **Poster.** CFMIP; Boston, MA; June 2024.
7. "Exploring CO₂-Induced Stratocumulus Cloud Breakup in CESM." **Talk & Poster.** Gordon Research Seminar & Conference; Lewiston, ME; July 2023.
8. "Surface-Active Organics: Results from a Particle-Based Microphysics Model Calibrated with Laboratory Experiments." **Talk.** AMS annual meeting; Denver, CO; January 2023.
9. "Stratocumulus cloud feedbacks in a simple physical model." **Talk.** CalGFD; Pasadena, CA; August 2022.
10. "Extended mixed-layer theory for the stratocumulus-cumulus transition in climatology and under extreme CO₂ forcing." **Talk.** CFMIP; Seattle, WA; July 2022.
11. "Successes, Challenges, and Lessons Learned by the Caltech URGE Pod." **Poster.** AGU 2021 Fall Meeting; New Orleans, LA; December 2021.
12. "Analytical Theory for Stratocumulus Cloud Feedbacks." **Talk.** AGU 2021 Fall Meeting; New Orleans, LA; December 2021.

13. “Quantifying Cloud Sensitivity to Aerosol Hygroscopicity using a Lagrangian Cloud Model.” **Virtual talk.** ICCP; August 2021.
14. “Top-of-atmosphere albedo bias from neglecting three-dimensional radiative transfer through clouds.” **Virtual poster.** AGU 2020 Fall Meeting; December 2020.
15. “Investigating Stratocumulus Cloud Sensitivity to Aerosol Hygroscopicity using a Lagrangian Particle-based Microphysics Model.” **Poster.** AGU 2019 Fall Meeting; San Francisco, CA; December 2019.
16. “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.
17. “ChiWIS: The Chicago Water Isotope Spectrometer.” **Poster** Goldschmidt; Boston, MA; Aug 2018.
18. “Comparison of water vapor from observations and models in the Asian Monsoon UTLS region.” **Poster.** AGU 2017 Fall Meeting; New Orleans, LA; Dec 2017.

Grants

1. Co-PI: Spark Climate Solutions proposal “Understanding observed trends in Earths energy imbalance and assessing implications for future warming using climate model simulations” (2026-2027)
2. Collaborator: Spark Climate Solutions proposal “CERESMIP” (2026-2027)
3. Collaborator: NOAA ERB proposal “Integrating Observations and Modeling in Support of Process Understanding Relevant to Solar Radiation Modification Research” (*Selected*)
4. PI: NOAA Climate & Global Change Postdoctoral Fellowship (2023-2024)
5. PI: NSF Graduate Research Fellowship (2018-2023)

Awards

<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

- **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

- **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.
- **100-hour Weather and Climate Livestream** May 2025, 2026
Speaker, Host, Panel Moderator, Organizer
 - Speaker, host, and panel discussion moderator for the 100-hour Weather and Climate Livestream event in May 2025.
 - Organizer and host for the 2026 Livestream.
- **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

- **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
- **Co-convener** for AMS Annual Meeting session on “From Weather Modification to Climate Intervention: Aerosol Impacts on Clouds Across Scales” (2027)
- **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)