**Zachary McGraw**
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## Research Focus

I am an atmospheric physicist working to advance understanding of how aerosol and cloud processes shape Earth's climate system. My research uses physical theory and a hierarchy of models to close gaps in the mechanistic understanding of interactions among microphysical processes, radiation, convection, atmospheric dynamics, precipitation, and temperature.

## Education

***Ph.D.*** *in Geosciences* 12/2020
University of Oslo | Department of Geosciences
Supervisor: Trude Storelvmo
Thesis title: *Global radiative impacts of aerosol variations through mixed-phase and cirrus clouds*

***M.Phil.*** *in Atmospheres, Oceans & Climate Dynamics* 05/2017
Yale University | Department of Geology & Geophysics
Supervisor: Trude Storelvmo

***B.Sc.*** *double-majoring in Physics, Applied Math & Statistics* 05/2012
*Johns Hopkins University*

## Work Experience

***Postdoctoral researcher*** at the University of Vienna 02/2026 – present
Supervisors: Blaž Gasparini & Aiko Voigt
– High-resolution modeling of ice cloud seeding and climate
– Fundamental research on tropical convection and clouds

***Postdoctoral research scientist*** at Columbia University & NASA GISS 01/2021 – 01/2026
Supervisor: Lorenzo Polvani
– Research projects on how stratospheric aerosols influence temperature and precipitation
– Continued research on the role of clouds in Earth's climate system.
– Development tasks improving aerosol treatment in the NASA GISS ModelE global model

***Research assistant*** at Columbia University & NASA GISS 10/2012 – 07/2014
Supervisors: Susanne Bauer & Kostas Tsigaridis
– Programming automated reading of aerosol measurements for model input and visualization
– Climate model validation tasks using flight campaign measurements

***Visiting undergraduate researcher*** at the University of Galway 06/2010 – 07/2010
within the Centre for Climate and Air Pollution Studies (C-CAPS) under Prof. Colin O'Dowd
– Aided modeling of the Eyjafjallajökull volcanic ash that disrupted European flights in 2010

## Peer-Reviewed Publications

**McGraw, Z.**, & Polvani, L. M. (2026). Direct Radiative Impacts of Stratospheric Aerosols on the Tropical Troposphere: Clouds, Precipitation, and Circulation in Convection-Resolving and Global Simulations. *Journal of Climate*, e250688. https://doi.org/10.1175/JCLI-D-25-0688.1

**McGraw, Z.**, & Polvani, L. M. (2025). Do Climate Models Support Claims of Volcanic Global Catastrophes?. *Geophysical Research Letters*, *52*(18), e2025GL117611. https://doi.org/10.1029/2025GL117611

Raiter, D., **McGraw, Z.**, & Polvani, L. M. (2025). Non-linear and distinct responses of temperature and precipitation to volcanic eruptions with stratospheric sulfur injection from 5 to 160 Tg. *Geophysical Research Letters*, *52*(20), e2025GL116372. https://doi.org/10.1029/2025GL116372

**McGraw, Z.**, Polvani, L. M., Gasparini, B., Van de Koot, E. K., Voigt, A. The Cloud Radiative Response to Surface Warming Weakens Hydrological Sensitivity. *Geophysical Research Letters*, 52, e2024GL112368. https://doi.org/10.1029/2024GL112368

Gjelsvik, A. B., David, R. O., Carlsen, T., Hellmuth, F., Hofer, S., **McGraw, Z.**, Sodemann, H., & Storelvmo, T. (2025). Using a region-specific ice-nucleating particle parameterization improves the representation of Arctic clouds in a global climate model. *Atmospheric Chemistry and Physics*, *25*(3), 1617-1637. https://doi.org/10.5194/acp-25-1617-2025

Hofer, S., Hahn, L. C., Shaw, J. K., **McGraw, Z.**, Bruno, O., Hellmuth, F., Pietschnig, M., Mostue, I.A., David, R.O., Carlsen, T. & Storelvmo, T. (2024). Realistic representation of mixed-phase clouds increases projected climate warming. *Communications Earth & Environment*, *5*(1), 390. https://doi.org/10.1038/s43247-024-01524-2

**McGraw, Z.**, & Polvani, L. M. (2024). How volcanic aerosols globally inhibit precipitation. Geophysical Research Letters, 51(13), e2023GL107930. https://doi.org/10.1029/2023GL107930

**McGraw, Z.**, DallaSanta, K., Polvani, L. M., Tsigaridis, K., Orbe, C., & Bauer, S. E. (2024). Severe global cooling after volcanic super-eruptions? The answer hinges on unknown aerosol size. *Journal of Climate*, 37(4), 1449-1464. https://doi.org/10.1175/JCLI-D-23-0116.1

**McGraw, Z.**, Storelvmo, T., Polvani, L. M., Hofer, S., Shaw, J. K., & Gettelman, A. (2023). On the links between ice nucleation, cloud phase, and climate sensitivity in CESM2. *Geophysical Research Letters*, 50(17), e2023GL105053. https://doi.org/10.1029/2023GL105053

Gettelman, A., Morrison, H., Eidhammer, T., Thayer-Calder, K., Sun, J., Forbes, R., **McGraw, Z.**, Zhu, J., Storelvmo, T., & Dennis, J. (2023). Importance of ice nucleation and precipitation on climate with the Parameterization of Unified Microphysics Across Scales version 1 (PUMASv1). Geoscientific Model Development, 16(6), 1735-1754. https://doi.org/10.5194/gmd-16-1735-2023

Zhu, J., Otto-Bliesner, B. L., Brady, E. C., Gettelman, A., Bacmeister, J. T., Neale, R. B., Poulsen, C. J., Shaw, J. K., **McGraw, Z.**, & Kay, J. E. (2022). LGM paleoclimate constraints inform cloud parameterizations and equilibrium climate sensitivity in CESM2. *Journal of Advances in Modeling Earth Systems*, *14*(4), e2021MS002776. https://doi.org/10.1029/2021MS002776

Shaw, J., **McGraw, Z.,** Bruno, O., Storelvmo, T., & Hofer, S. (2022). Using satellite observations to evaluate model microphysical representation of arctic mixed-phase clouds. *Geophysical Research Letters*, *49*(3), e2021GL096191. https://doi.org/10.1029/2021GL096191

**McGraw, Z.**, Storelvmo, T., Samset, B. H., & Stjern, C. W. (2020). Global radiative impacts of black carbon acting as ice nucleating particles. *Geophysical Research Letters*, 47(20), e2020GL089056. https://doi.org/10.1029/2020GL089056

**McGraw, Z.**, Storelvmo, T., David, R. O., & Sagoo, N. (2020). Global radiative impacts of mineral dust perturbations through stratiform clouds. *Journal of Geophysical Research: Atmospheres*, 125(23), e2019JD031807. https://doi.org/10.1029/2019JD031807

Gasparini, B., **McGraw, Z.**, Storelvmo, T., & Lohmann, U. (2020). To what extent can cirrus cloud seeding counteract global warming?. *Environmental Research Letters*, *15*(5), 054002. https://doi.org/10.1088/1748-9326/ab71a3

O'Dowd, C., Varghese, C., Martin, D., Flanagan, R., McKinstry, A., Ceburnis, D., Ovadnevaite, J., Martucci, G., Bialek, J., Monahan, C., Berresheim, H., Vaishya, A., Grigas, T., **McGraw, Z.**, Jennings, S.G., Langmann, B. Semmler, T., McGrath, R. "The Eyjafjallajökull ash plume–Part 2: Simulating ash cloud dispersion with REMOTE." *Atmospheric Environment* 48 (2012): 143-151. https://doi.org/10.1016/j.atmosenv.2011.10.037

**Manuscripts Under Review**

**McGraw, Z.**, & Gasparini, B. (2026). No Reduction of Tropical Convection with Warming Expected from Theory or Models. Manuscript under review at *Geophysical Research Letters*. Preprint at https://arxiv.org/abs/2608.14483

**McGraw, Z.**, Gasparini, B., Mol, W., & Voigt, A. (2026). Reconciling the Lack of a Robust Anvil Cloud Amount Response to Warming. Manuscript under review at *Geophysical Research Letters*. Preprint at https://arxiv.org/abs/2609.00429

**McGraw, Z.**, Goldman, B. O., & Polvani, L. M. (2026). No Evidence for Strongly Enhanced Northern Hemisphere Cooling from Extratropical Versus Tropical Eruptions. *Geophysical Research Letters*, in revision.

Mahowald, N., Liddy, H., Marlon, J., Tsigaridis, K., Winckler, G., Hamilton, D., Kok, J., Sigl, M., Abell, J., Aboagye-Okyere, A., Amooli, J. A., Albani, S., Bauer, S., Beaudon, E., Brown, H., Chellman, N., Cosentino, N., Goodkin, N., Guiterman, C., Hantson, S., He, C., Intveld, A., Kaplan, J., Klavans, J., Lambert, F., Liu, H., Loutre, M.-F., McConnell, J., **McGraw, Z.**, Mezuman, K., Miller, R., O'Mara, N., Ong, M. R., Schmidt, G., Vachula, R., Wu, L., & Zhang, B. (2026). Characterizing Natural Aerosol Variability and its Uncertainty in the Earth System. Manuscript under review at *Atmospheric Chemistry and Physics*. Preprint at https://doi.org/10.5194/egusphere-2026-4532

## Invited Presentations

*The Value of Critiquing Climate Projections*, Symposium for Stephen E. Schwartz, Stony Brook University, NY, USA, 2 June 2026.

*Incorporating Clouds into Global Precipitation Change: Toward Explained and Constrained Responses to Warming and Aerosols*, Joint Oslo Seminar in atmospheric, ocean and climate science, University of Oslo, Norway, 12 May 2026.

*Are Volcanic Impacts on Global Climate Overblown?*, Invited talk for the BOKU-Met Seminar, University of Natural Resources and Life Sciences (BOKU), Austria, 24 March 2026.

*Global Impacts of Very Large Volcanic Eruptions: Lessons & Limits of Climate Modeling.* Invited talk for the GMAO seminar at Goddard Space Flight Center, MD, USA, May 27, 2025.

*The Cloud Conundrum in Climate Prediction.* Invited talk for the ECSD Seminar at Brookhaven National Laboratory, NY, USA, February 27, 2025.

*Do Volcanic Aerosols Severely Alter Global Climate?* Invited talk at the American Meteorological Society annual meeting, LA, USA, January 16, 2025.

*Are Volcanic Impacts on Global Climate Overblown?* Invited talk for the Atmosphere Ocean Science series, NYU Courant Institute of Mathematical Sciences, NY, USA, April 3, 2024.

## Teaching Experience

***Teaching fellow*** at Yale University. Courses:

- Atmosphere, Ocean, & Environmental Change + lab (Fall 2014)
- Physics of Weather and Climate (Fall 2015)
- Climate Dynamics (Spring 2017)
- Atmosphere, Ocean, & Environmental Change + lab (Fall 2017)

## Skills

- *Climate and atmospheric model development*. Extensive experience developing and improving atmospheric models, including aerosol and cloud microphysics in GISS ModelE and CESM2.

- *Process-based and high-resolution numerical experimentation*. Design and implementation of custom experiments across global, convection-resolving, and LES models (GISS ModelE, CESM, SAM, WRF, ICON) to isolate physical mechanisms and connect process-level behavior to climate-scale responses.

- *Climate model diagnosis and evaluation*. Diagnose model behavior using radiative kernels, process-denial experiments, energy budgets, mechanistic decomposition, and comparison with observations, theory, CMIP, and RCEMIP simulations.

- *Physical and analytical modeling*. Strong analytical and physical understanding of atmospheric thermodynamics, radiation, convection, clouds, precipitation, aerosol–cloud interactions, and atmospheric dynamics.

## Awards

- Co-I and wrote a large portion of a selected $1.04 million NASA grant proposal entitled *Advancing Convective Microphysics in GISS ModelE to Improve Processes Driving Intense Convective Precipitation and Anvil Cloud Feedback*. This was among the 23% of Modeling, Analysis, and Prediction (MAP) program submissions deemed suitable for award on 2 May 2025. However, no funds were dispensed due to the current US federal government situation.

- Best NASA GISS papers 2024 | Awarded place #2 for writing the paper *Severe global cooling after volcanic super-eruptions? The answer hinges on unknown aerosol size.*

## Leadership

- Led/facilitated multiple meetings at NASA GISS. This includes organizing a monthly cloud group meeting (Aug. 2024 – Jan. 2026), and co-leading with Dr. Kate Marvel a monthly discussion on geoengineering (Apr. 2024 – Jan. 2026).

- Co-mentored a total so far of 5 students and early-career researchers between the University of Oslo, Columbia University, and the University of Vienna (ongoing).