

Education

Princeton University, Princeton, NJ

Ph.D., Atmospheric and Oceanic Sciences

Sept. 2019

Advisor: Yi Ming

Princeton University, Princeton, NJ

M.A., Atmospheric and Oceanic Sciences

Sept. 2016

Cornell University, Ithaca, NY

B.S., Engineering Physics; Honors in Research; magna cum laude

May 2014

Thesis Advisor: Natalie Mahowald

Research Experience

Allen Institute for Artificial Intelligence, Princeton, NJ

Research Engineer

Sept. 2021 - Present

- A continuation of our work at Vulcan Inc.

Vulcan Inc., Princeton, NJ

Software Engineer for Climate Model Development

Aug. 2019 - Aug. 2021

- Supported Vulcan Climate Modeling's efforts as a member of both VCM's ML team and GFDL's SHIELD model development team.
- Contributed code to GFDL's SHIELD model to enable online coarse-graining of diagnostics and model restart files in physically consistent ways. Ran multiple global 3-km resolution simulations with outputs coarse-grained online to 25-km resolution to produce 50+ TB datasets with high frequency output for machine learning training and testing.
- Helped build and use infrastructure to run a Python-wrapped version of NOAA's FV3GFS model for machine learning experiments, in which output from the 3-km runs was used to train ML models to improve coarse-resolution simulations.

Princeton University, Program in Atmospheric and Oceanic Sciences, Princeton, NJ

Research Assistant

Sept. 2014 - Aug. 2019

- Characterized the role of water vapor in the ITCZ response to hemispherically asymmetric perturbations.
- Demonstrated that South Asian monsoon low pressure systems can be simulated in an idealized moist GCM, and that the storms exhibit some properties consistent with moisture vortex instability theory, as well as some properties that deviate from it.
- Studied the sensitivity of equatorial wave variability in an idealized moist GCM to various forms of heating perturbations.

Cornell University, Department of Earth and Atmospheric Sciences, Ithaca, NY

Research Assistant

Jan. 2011 - Mar. 2017

- Characterized the episodicity of forest and grass fires and developed 7 new prescribed emissions cases to test the impact of fire episodicity on fire's aerosol direct and indirect radiative forcings.
- Implemented 8 GCM lightning parameterizations in CAM5, compared their results to LIS/OTD observations, and studied their future projections.


Teaching Experience

Princeton University, Princeton Environmental Institute, Princeton, NJ

Modeling the Earth System (ENV367)

Fall 2017

Assistant in Instruction

- Adapted an existing compact Earth System Model  for use as a teaching tool. Wrote comprehensive web-based documentation for the model.
- Authored lab exercises to help students learn about the features and limitations of the model, and illustrate Earth system modeling concepts.

- Held weekly office hours, wrote official solutions, and graded homework and exam problems.

Publications

In press

Bretherton, C. S., Henn, B., Kwa, A., Brenowitz, N. D., Watt-Meyer, O., McGibbon, J., Perkins, W. A., **Clark, S. K.**, Harris, L. M. "Correcting coarse-grid weather and climate models by machine learning from global storm resolving simulations." Accepted to *Journal of Advances in Modeling the Earth System*. [↗](#)

Xiang, B., Harris, L., Delworth, T. L., Wang, B., Chen, G., Chen, J-H., **Clark, S. K.**, Cooke, W. F., Gao, K., Huff, J. J., Jia, L., Johnson, N., Kapnick, S. B., Lu, F., Sun, Y., Tong, M., Yang, X., Zeng, F., Zhao, M., Zhou, L., and Zhou, X.. "The GFDL SPEAR S2S Prediction System and Its Prediction of Different Types of MJO." Accepted to *Bulletin of the American Meteorological Society*. [↗](#)

Refereed

McGibbon, J., Brenowitz, N. D., Cheeseman, M., **Clark, S. K.**, Dahm, J., Davis, E., Elbert, O. D., George, R. C., Harris, L. M., Henn, B., Kwa, A., Perkins, W. A., Watt-Meyer, O., Wicky, T., Bretherton, C. S., and Fuhrer, O. (2021). "fv3gfs-wrapper: a Python wrapper of the FV3GFS atmospheric model." *Geoscientific Model Development*, 14, 4401-4409. [↗](#)

Watt-Meyer, O., Brenowitz, N. D., **Clark, S. K.**, Henn, B., Kwa, A., McGibbon, J., Perkins, W. A., and Bretherton, C. S. (2021). "Correcting weather and climate models by machine learning nudged historical simulations." *Geophysical Research Letters*, 48(15), e2021GL092555. [↗](#)

Harris, L., Zhou, L., Lin, S.-J., Chen, J.-H., Chen, X., Gao, K., Morin, M., Rees, S., Sun, Y., Tong, M., Xiang, B., Bender, M., Benson, R., Cheng, K.-Y., **Clark, S. K.**, Elbert, O. D., Hazelton, A., Huff, J. J., Kaltenbaugh, A., ... Stern, W. (2020). "GFDL SHiELD: A Unified System for Weather-to-Seasonal Prediction." *Journal of Advances in Modeling Earth Systems*, 12(10), e2020MS002223. [↗](#)

Narinesingh, V., Booth, J. F., **Clark, S. K.**, Ming, Y. (2020). "Atmospheric blocking in an aquaplanet and the impact of orography." *Weather and Climate Dynamics*, 1(2), 293–311. [↗](#)

Clark, S. K., Ming, Y., and Adames, Á. F. (2020). "Monsoon low pressure system like variability in an idealized moist model." *Journal of Climate*, 33(6), 2051-2074. [↗](#)

Adames, Á. F., Kim, D., **Clark, S. K.**, Ming, Y., and Inoue, K. (2019). "Scale analysis of moist thermodynamics in a simple model and the relationship between moisture modes and gravity waves." *Journal of the Atmospheric Sciences*, 79, 3863-3881. [↗](#)

Clark, S. K., Ming, Y., Held, I. M., and Philipps, P. J. (2018). "The Role of the Water Vapor Feedback in the ITCZ Response to Hemispherically Asymmetric Forcings." *Journal of Climate*, 31(9), 3659-3678. [↗](#)

Clark, S. K., Ward, D. S., and Mahowald, N. M. "Parameterization-based uncertainty in future lightning flash density." *Geophysical Research Letters*, 44(6), (2017), 2893-2901. [↗](#)


Clark, S. K., Ward, D. S., and Mahowald, N. M. "The sensitivity of global climate to the episodicity of fire aerosol emissions." *Journal of Geophysical Research: Atmospheres*, 120(22) (2015), 11589-11607. [↗](#)

Ph.D. Thesis

Clark, S. K. "Controls on tropical mean state and intraseasonal precipitation variability in an idealized moist atmospheric model." Ph.D. Thesis. Program in Atmospheric and Oceanic Sciences, Princeton University

(2019).

Software Development

`xarray`, A widely-used Python library providing N-dimensional labeled array data structures 

Contributor and Core Developer

Feb. 2017 - Present


- Led an effort to add first-class support of non-standard calendar types frequently used in climate science.
- Responsible for taking part in carefully reviewing new contributions, fixing bugs, adding requested features, and answering user/developer questions.

`cftime`, A Python library providing datetime instances for non-standard calendars 

Contributor

Feb. 2018 - Present







- Enabled exact numerical decoding and encoding of datetimes.
- Proposed strategy that led to speeding up fundamental operations, e.g. datetime construction and timedelta arithmetic, by 200 to 400x.

`nc-time-axis`, A Python library providing the ability to plot `cftime` datetimes in `matplotlib` 

Contributor and Core Developer

Jan. 2019 - Present

- Enabled plotting `cftime.datetime` objects directly in `matplotlib`, instead of requiring a wrapped version of a `cftime.datetime` object.

Contributor to other libraries in the scientific Python community, including `dask-jobqueue` , `gcsfs` , and `aospy` . Primary author of `faceted` , `xdiff` , and `xpartition` .

General Technical Skills

- Experienced in writing HPC-friendly Fortran code for use in atmospheric models, e.g. NCAR's CAM5 and GFDL's Flexible-Modeling-System-based idealized moist model.
- Practiced in collaborative software engineering workflows involving version control with `git`, unit testing, and code review.
- Familiar configuring continuous integration services for automated testing of software projects, e.g. with Travis CI or Jenkins.
- Expert in leveraging PyData ecosystem tools, e.g. `xarray`, `NumPy`, `pandas`, and `matplotlib`, to draw insights from data.
- Experienced in analyzing terabyte-scale datasets in a high-performance computing context. Regular user of tools for distributed computing, e.g. packages in the `dask` ecosystem, as well as tools for building data processing pipelines, e.g. `snakemake`.

Selected Honors and Awards

Arnold Guyot Teaching Award, *Princeton University Department of Geosciences*

2018

NDSEG Fellowship, *American Society for Engineering Education*

2016-2019

Dorothy and Fred Chau Award (Excellence in Undergraduate Research), *Cornell AEP*

May 2014

Rawlings Cornell Presidential Research Scholar, *Cornell*

2010-2014


Professional Experiences

Participant, *Columbia AOSPy Workshop, founding meeting of the Pangeo Data initiative* 

Nov. 2016

Organizer, *Princeton AOS Workshop on Tropical Dynamics*

2016

Participant, *Dynamical Core Model Intercomparison Project Workshop* 

June 2016

Service

Assistant mentor to NOAA Hollings Scholar Bridgette Befort (2017).

Reviewing

Peer-reviewed manuscripts for *Nature*, *Nature Climate Change*, *Journal of Geophysical Research – Atmospheres*, *Journal of Climate*, *Quarterly Journal of the Royal Meteorological Society*, and GFDL internal manuscript review.

Presentations

Clark, S. K., Brenowitz, N., Henn, B. M., Kwa, A., McGibbon, J., Perkins, W. A., Watt-Meyer, O., and Bretherton, C.S. "Applying machine learning parameterization through coarse graining to improve the skill in simulating multiple climates in a full complexity GCM." AGU Fall Meeting, December 2021. Virtual Poster Presentation.

Clark, S. K., Brenowitz, N., Henn, B. M., Kwa, A., McGibbon, J., Perkins, W. A., Watt-Meyer, O., and Bretherton, C.S. "Applying machine learning parameterization through coarse graining to improve the skill in simulating multiple climates in a full complexity GCM." NOAA Artificial Intelligence Workshop, September 2021. Virtual Oral Presentation.

Clark, S. K., Brenowitz, N., Bretherton, C. S., Henn, B. M., Kwa, A., McGibbon, J., Perkins, W. A., Watt-Meyer, O., Chen, X., Harris, L., Zhou, L. "Using nudging to investigate biases in a global 3 km resolution simulation with GFDL's X-SHIELD model." AGU Fall Meeting 2020, December 2020. Virtual Poster Presentation.

Clark, S. K., Brenowitz, N., Henn, B. M., Kwa, A., McGibbon, J., Perkins, W. A., Watt-Meyer, O., Harris, L., Bretherton, C.S. "Challenges associated with training a machine-learning based moist physics parameterization by coarse-graining in a model with topography." NOAA Artificial Intelligence Workshop, December 2020. Virtual Oral Presentation.

Clark, S. K., Ming, Y., Adames, Á. F. "An idealized framework for simulating monsoon low pressure systems and their potential sensitivity to the mean state." AGU Fall Meeting 2018, Washington D.C., December 2018. Poster Presentation.

Clark, S. K., Ming, Y. "Investigating synoptic-scale monsoonal disturbances in an idealized moist model." AGU Fall Meeting 2017, New Orleans, LA, December 2017. Poster Presentation.

Clark, S. K., Ming, Y., Held, I. M., and Philipps, P. J. "The role of water vapor in the ITCZ response to hemispherically asymmetric forcings." Dynamics seminar series, Princeton University, Princeton, NJ, November 2017. Oral Presentation.

Clark, S. K., Ming, Y., and Held, I. M. "The role of water vapor in the ITCZ response to hemispherically asymmetric forcings." AGU Fall Meeting, San Francisco, CA, December 2016. Poster Presentation.

Hill, S. A., **Clark, S. K.** "The other 'aospy': automated climate data analysis and management." AOSPy Workshop at Columbia University, New York, NY, November 2016. Oral Presentation.

Clark, S. K., Ming, Y., and Held, I. M. "The role of water vapor in the ITCZ response to hemispherically asymmetric forcings." WCRP Model Hierarchies Workshop, Princeton, NJ, November 2016. Poster Presentation.

Clark, S. K., Ming, Y., and Held, I. M. "The role of water vapor in the ITCZ response to hemispherically asymmetric forcings." Dynamical Core Model Intercomparison Project, Boulder, CO, June 2016. Poster Presentation.

Clark, S. K., Ming, Y., and Held, I. M. "Climate Impacts of Inter-hemispherically Asymmetric Radiative Forcing." AGU Fall Meeting, San Francisco, CA, December 2015. Poster Presentation.

Clark, S. K., Ming, Y., and Held, I. M. "Climate Impacts of Inter-hemispherically Asymmetric Radiative Forcing." Gordon Research Conference, Lewiston, ME, July 2015. Poster Presentation.

Clark, S. K., Ward, D. S., and Mahowald, N. M. "The implementation and evaluation of five lightning parameterizations in a global climate model." Cornell Applied and Engineering Physics Honors Thesis Presentation, Ithaca, NY, May 2014.

Clark, S. K., Ward, D. S., and Mahowald, N. M. "The sensitivity of global climate to the episodicity of fire aerosol emissions." SESSA Spring Research Symposium, Ithaca, NY, May 2013. Poster Presentation.

Clark, S. K., Ward, D. S., and Mahowald, N. M. "Climate Model Responses to Increased Episodicity in Prescribed Fire Aerosol Emissions." CESM Workshop, Breckenridge, CO, June 2012. Poster Presentation.

Clark, S. K., Ward, D. S., and Mahowald, N. M. "Climate Model Responses to Increased Episodicity in Prescribed Fire Aerosol Emissions." SESSA Spring Research Symposium, Ithaca, NY, May 2012. Poster Presentation.

Activities

Varsity Tennis, Cornell University

Sept. 2010 - May 2014