

Nicholas A. Davis

Scientist I
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Atmospheric Chemistry Observations and Modeling
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Research Summary

I develop experimental modeling techniques that deliver direct answers to scientific questions related to climate change, air pollution, and the causes of extreme weather through the lens of whole atmosphere dynamic and chemistry.

Education

Colorado State University (CSU)

Ph.D., Atmosphere Science 2013-2017
Title: "The dynamics of Hadley circulation variability and change"

M.S., Atmospheric Science 2011-2013
Title: "Seasonal to multi-decadal variability of the width of the tropical belt"

University of Washington (UW) 2007-2011

B.S., Atmospheric Sciences
B.S., Applied and Computational Math Sciences
Minor, Mathematics

Professional Experience

Scientist I, National Center for Atmospheric Research, Atmospheric Chemistry Observations and Modeling Division, Boulder, Colorado 2019-

My primary focus is to create new modeling and computational methods that can help us develop a more comprehensive, predictive understanding of the atmospheric circulation and its impacts on surface weather, air pollution, and climate.

Postdoctoral Research Associate, Cooperative Institute for Research in Environmental Sciences at the Chemical Sciences Division, NOAA Earth System Research Laboratory, Boulder, Colorado 2017-2019

Advisors: Sean Davis, Robert Portmann

I developed new specified dynamics schemes in WACCM to improve the accuracy of historical trends and variability. These new methods are being used to assess recent changes in stratospheric ozone and ozone depleting substances. In the troposphere, I reduced the uncertainties in past estimates of Hadley cell expansion using basic physical laws.

Graduate Research Assistant, Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado 2011-2017

Advisor: Thomas Birner

I created a new modeling framework within an idealized gray-radiation model that separates the mean flow and time-mean eddy components of the flow, and used this to study the impact of eddies on Hadley circulation expansion. I also identified the distinct characteristics of the

general circulation in true axisymmetric and eddy-inhabited atmospheres. More practically, I also developed robust, objective metrics for the width of the tropical belt and assessed their usefulness as proxies for the Hadley cell edges.

Undergraduate Research Assistant, Department of Atmospheric Science,
University of Washington, Seattle, Washington

2009-2011

Advisors: Dargan Frierson, Robert Wood

I used reanalysis output to test a theoretical scaling for midlatitude tropospheric stability. I also developed and tested an improved scaling for the estimated inversion strength above subtropical stratocumulus regions.

Publications

- Davis, N. A.**, et al., Balancing resolved gravity waves and simplified scale-aware gravity wave physics in regionally-refined CESM2(WACCM6), in preparation.
- Davis, N. A.**, The response of the atmospheric circulation to greenhouse gas forcings is a negative climate feedback, in preparation.
- Davis, N. A.**, D. Visoni, R. R. Garcia, D. E. Kinnison, D. R. Marsh, M. Mills, J. H. Richter, S. Tilmes, C. G. Bardeen, A. Gettelman, A. A. Glanville, D. G. MacMartin, A. K. Smith, and F. Vitt (2022), Climate, variability, and climate sensitivity of “Middle Atmosphere” chemistry configurations of the Community Earth System Model Version 2, Whole Atmosphere Community Climate Model Version 6 (CESM2(WACCM6)), *J. Adv. Mod. Earth Sys.*, in review.
- Davis, S. M., **N. A. Davis**, R. W. Portmann, E. Ray, and K. H. Rosenlof (2022), The role of tropical upwelling in explaining discrepancies between recent modeled and observed lower stratospheric ozone trends, *Atmos. Chem. Phys.*, in review.
- Zhang, J., D. Wuebbles, D. Kinnison, J. H. Pfaender, S. Tilmes, **N. A. Davis** (2022), Potential impacts on ozone and climate from a proposed fleet of supersonic aircraft, *Earth's Future*, in review.
- Richter, J. H., A. A. Glanville, J. Edwards, B. Kauffman, **N. A. Davis**, A. Jaye, H. Kim, N. M. Pedatella, L. Sun, J. Berner, W. M. Kim, S. G. Yeager, G. Danabasoglu, J. M. Caron, and K. W. Oleson (2022), Subseasonal Earth system prediction with CESM2, *Weath. and Forecast.*, 37, 797-815.
- Davis, N. A.**, J. H. Richter, A. A. Glanville, J. Edwards, and E. LaJoie (2022), Limited surface impacts of the January 2021 sudden stratospheric warming, *Nat. Comm.*, 13, 1136.
- Davis, N. A.**, Callaghan, P., Simpson, I. R., and Tilmes, S. (2022), Specified dynamics scheme impacts on wave-mean flow dynamics, convection, and tracer transport in CESM2 (WACCM6), *Atmos. Chem. Phys.*, 22, 197–214.
- Davis, N. A.**, and Birner, T. (2022), Eddy-mediated Hadley cell expansion due to axisymmetric angular momentum adjustment to greenhouse gas forcings, *J. Atmos. Sci.*, 79, 141-159.
- Davis, N. A.**, J. H. Richter, J. Edwards, and A. A. Glanville (2021), A positive zonal wind feedback on sudden stratospheric warming development revealed by CESM2 (WACCM6) forecasts, *Geophys. Res. Lett.*, 48, e2020GL090863.
- Pfister, G. G., S. D. Eastham, A. F. Arellano, B. Aumont, K. C. Barsanti, M. C. Barth, A. Conley, **N. A. Davis**, L. K. Emmons, J. D. Fast, A. M. Fiore, B. Gaubert, S. Goldhaber, C. Granier, G. A. Grell, M. Guevara, D. K. Henze, A. Hodzic, X. Liu, D. R. Marsh, J. J. Orlando, J. M. C. Plane, L. M. Polvani, K. H. Rosenlof, A. L. Steiner, D. J. Jacob, and G. P. Brasseur (2020), A Multi-Scale

Infrastructure for Chemistry and Aerosols - MUSICA, *Bull. Amer. Meteor. Soc.*, 101, E1743-E1760.

- Staten, P. W., K. M. Grise, S. M. Davis, K. B. Karlsrukas, D. W. Waugh, A. Maycock, Q. Fu, O. Adam, I. Simpson, R. J. Allen, K. H. Rosenlof, G. Chen, C. C. Ummenhofer, X.-W. Quan, J. P. Kossin, **N. A. Davis**, and S.-W. Son (2020), Tropical widening: from global variations to regional impacts, *Bull. Amer. Meteor. Soc.*, 101. E897-E904.
- Davis, N. A.**, R. W. Portmann, S. M. Davis, P. Yu, E. Ray, and K. Rosenlof (2020), An assessment of specified dynamics schemes in CESM-WACCM, *Global Mod. Dev.*, 13, 717–734, 10.5194/gmd-13-717-2020.
- Staten, P., K. M. Grise, S. Davis, K. Karlsrukas, **N. A. Davis** (2019), Regional widening of tropical overturning-forced change, natural variability, and recent trends, *J. Geophys. Res. Atmos.*, 124, 6104– 6119.
- ¹**Davis, N. A.** and T. Birner (2019), Eddy influences on the Hadley circulation, *J. Adv. Mod. Earth Sci.*, 11, 1563– 1581.
- Adam, O., K. M. Grise, P. Staten, I. R. Simpson, S. M. Davis, **N. A. Davis**, D. W. Waugh, and T. Birner: The TropD software package (v1) (2018), Standardized methods for calculating tropical width diagnostics. *Global Mod. Dev.*, 11, 4339-4357.
- Davis, N. A.** and S. M. Davis (2018), Reconciling Hadley cell expansion estimates in reanalyses, *Geophys. Res. Lett.*, 45.
- Waugh, D. W., K. M. Grise, W. J. M. Seviour, S. M. Davis, **N. A. Davis**, O. Adam, S.-W. Son, I. R. Simpson, P. W. Staten, A. C. Maycock, C. C. Ummenhofer, T. Birner, and A. Ming (2018), Revisiting the relationship among metrics of tropical expansion, *J. Climate*, 18, 7565–7581.
- ²**Davis, N. A.**, D. W. Waugh, and S. M. Davis (2018), New insights into tropical belt metrics, *CLIVAR Variations*, 16, 1-7.
- Davis, N. A.** and T. Birner (2017), On the discrepancies in tropical belt expansion between reanalyses and climate models and among tropical belt width metrics, *J. Climate*, 30, 1211-1231.
- Davis, N. A.**, D. J. Seidel, T. Birner, S. M. Davis, and S. Tilmes (2016), Changes in the width of the tropical belt due to simple radiative forcing changes in the GeoMIP simulations, *Atmos. Chem. Phys.*, 16, 10083-10095.
- Davis, N. A.** and T. Birner (2016), Climate model biases in the width of the tropical belt, *J. Climate*, 29, 1935-1954.
- Davis, N. A.** and T. Birner (2013), Seasonal to multi-decadal variability of the width of the tropical belt, *J. Geophys. Res.*, 118.
- Charlton-Perez, A.J. et al. (27 co-authors including **N. A. Davis**) (2013), On the lack of stratospheric dynamical variability in low-top versions of the CMIP5 models, *J. Geophys. Res.*, 118, 2494-2505.

¹ Code modifications hosted at https://github.com/nicholasadavis/gfdl_aquaplanet

² Non-refereed

Frierson, D. M. W. and N. A. Davis (2011), The seasonal cycle of midlatitude static stability over land and ocean in global reanalyses, *Geophys. Res. Lett.*, 38, L13803.

Professional Service

Member, Advanced Study Program Postdoctoral Fellowship Committee <i>Interviewing and ranking prospective applicants.</i>	2020-
Co-chair, CESM Whole Atmosphere Working Group <i>Setting whole atmosphere model development and science goals for CESM.</i>	2020-
Co-chair, MUSICA Whole Atmosphere Working Group <i>Setting whole atmosphere model development and science goals for MUSICA.</i>	2019-
Search committee, NCAR ACOM Associate Director <i>Assessing and interviewing candidates, liaising with laboratory.</i>	2019-2020
Representative, Early Career Scientist Association, Steering Committee <i>Developing guiding documents and by-laws for the Early Career Scientist Association at NCAR. Acting as a liaison between NCAR management and early career scientists, hosting events.</i>	2019-2022
Member, International Space Science Institute Tropical Width Impacts on the Stratosphere <i>International project to determine stratosphere-troposphere, Hadley cell-Brewer Dobson circulation coupling in the tropics.</i>	2019-
Contributor, SPARC Reanalysis Intercomparison Project <i>International working group to document trends and variability in stratospheric circulation, chemistry, and transport in reanalysis products.</i>	2018-2021
Member, International Space Science Institute Tropical Width Diagnostics Intercomparison Project <i>International project to determine metrics that are useful proxies for the Hadley cell edges and disseminate a set of standard practices and suggested metrics for calculating the tropical belt edge latitudes.</i>	2017-2018
Member, US CLIVAR Changing Width of the Tropical Belt Working Group <i>International working group to advance the scientific understanding of variability and change in the Hadley circulation and the tropical belt width.</i>	2016-2018
Program Committee, 19th AMS Conference on the Middle Atmosphere <i>Judged abstracts, co-developed conference program, session chair.</i>	2016-2017
Member, AMS Middle Atmosphere Scientific and Technological Activities Committee <i>Judged student presentations, selected keynote speakers, and selected the committee for the 2017 conference.</i>	2013-2016
CSU Department of Atmospheric Science graduate representative <i>Acted as liaison between faculty and students, helped manage departmental awards, helped organize and judge abstracts for the</i>	2012-2014

Young Scientist Symposium on Atmospheric Research, managed approximately \$10,000 in student technology funds per year.

CSU Engineering Student Technology Committee representative 2012-2014
Served on committee in the College of Engineering. Co-judged internal grants and distributed approximately \$150,000 in technology and education funding, managed College of Engineering technology budget including hardware, software, building technology, and educational tools.

Seminars and Invited Talks

Meteorological Institute, University of Munich, Atmospheric Dynamics group	2022
The Batsheva de Rothschild Seminar on Climate and Wave Dynamics, Eilat, Israel.	2019
Department of Earth and Planetary Sciences, Johns Hopkins University	2019
University of Colorado Boulder, Department of Atmospheric and Oceanic Sciences, Oceans and Climate Lab	2017
NCAR, Climate and Global Dynamics Division, Climate Analysis Section	2016
NOAA, Earth System Research Laboratory, Chemical Sciences Division	2016
NCAR, Atmospheric Chemistry Observations and Modeling	2014

Conference and Workshop Presentations

*Poster presentation

23rd Conference on Atmospheric and Oceanic Fluid Dynamics, June 2022, Breckenridge, CO.

“Hadley cell expansion is an eddy-mediated response to the subtropical jet adjustment to greenhouse gas-like forcings”

CESM Workshop, June 2022, Boulder, Colorado.

“The state of WACCM”.

CESM Workshop, June 2022, Boulder, Colorado.

“The state of WACCM”.

2022 CESM Atmosphere Model, Whole Atmosphere, & Chemistry Climate Working Group Meeting, February 2022, Boulder, Colorado.

“The state of WACCM”.

American Geophysical Union Fall Meeting, December 2021, New Orleans

“Limited surface impacts of the January 2021 sudden stratospheric warming”.

CESM Workshop, June 2021, Boulder, Colorado.

“The state of WACCM”.

“Limited surface impacts of the January 2021 sudden stratospheric warming”.

2020 CESM Atmosphere Model, Whole Atmosphere, & Chemistry Climate Working Group Meeting, March 2020, Boulder, Colorado.

“Whole atmosphere modeling and science in MUSICA”.

CESM Workshop, June 2019, Boulder, Colorado.

“Improving the representation of stratospheric upwelling trends in Specified Dynamics WACCM”.

American Geophysical Union Fall Meeting, December 2018, Washington D.C.

“Reconciling Hadley cell expansion estimates in reanalyses”.

International Space Science Institute Working Group meeting, June 2018, Bern, Switzerland.

“Reconciling Hadley cell expansion estimates in reanalyses”.

American Geophysical Union Fall Meeting, December 2017, New Orleans.

“Decomposing the eddy-mean flow response of the Hadley circulation to greenhouse gas forcings.”

*19th Conference on the Middle Atmosphere, June 2017, Portland.

“Directly quantifying the role of eddies in driving Hadley circulation expansion in an idealized GCM.”

International Space Science Institute Working Group meeting, March 2017, Bern, Switzerland.

“Horizontal resolution issues related to the tropical belt width”

“An intercomparison of tropical belt metrics.”

US CLIVAR Changing Width of the Tropical Belt Working Group meeting, October 2016, Bloomington, Indiana.

“On the discrepancies in tropical belt expansion between reanalyses and climate models and among tropical belt width metrics.”

SPARC/DynVar Workshop, June 2016, Helsinki, Finland.

“A climate model grid size bias in the Hadley cell width.”

*3rd International Conference on GPS Radio Occultation, March 2016, Taipei, Taiwan.

“Estimating zonal-mean eddy fluxes of heat and momentum with COSMIC GPS-RO.”

AGU Chapman Conference on the Width of the Tropics: Climate Variations and Their Impacts, July 2015, Santa Fe, New Mexico.

“A climate model grid size bias in the width of the tropical belt.”

“Changes in the width of the tropical belt due to simple radiative forcing changes in GeoMIP.”

Fifth Geoengineering Model Intercomparison Project Meeting, July 2015, Boulder, Colorado.

“Changes in the width of the tropical belt due to simple radiative forcing changes in GeoMIP.”

*20th Conference on Atmospheric and Oceanic Fluid Dynamics, June 2015, Minneapolis, Minnesota.

“A climate model grid size bias in the width of the tropical belt.”

*American Geophysical Union Fall Meeting, Dec. 2014, San Francisco, California.

“Climate model biases in the width of the tropical belt.”

*Eighth FORMOSAT-3/COSMIC Data Users' Workshop, Oct. 2014, Boulder, Colorado.

“Assessing climate model performance with GPS-RO.”

19th Conference on Atmospheric and Oceanic Fluid Dynamics, June 2013, Newport, Rhode Island.

“Seasonal to multi-decadal variability in the width of the tropical belt.”

*American Geophysical Union Fall Meeting, Dec. 2012, San Francisco, California.

“Seasonal to multi-decadal variability in the width of the tropical belt.”

*Sixth FORMOSAT-3/COSMIC Data Users' Workshop, Oct. 2012, Boulder, Colorado.
“Validating estimates of the width of the tropical belt from reanalyses with
FORMOSAT-3/COSMIC radio occultation data.”

Awards and Funding

CSU Department of Atmospheric Science Herbert Riehl Award <i>M.S. student with the best refereed manuscript.</i>	2013
National Science Foundation Graduate Research Fellowship	2012-2015
CSU Program of Research and Scholarly Excellence Scholarship <i>Incoming student with the most distinguished record of research.</i>	2011-2012
UW Department of Atmospheric Science Phil Church Award <i>Undergraduate with the greatest contributions to learning and research.</i>	2011

Teaching and Outreach

Mentor, Seo-Yeon Kim, ASP Graduate Visitor <i>Project: Hadley cell and eddy-driven jet decoupling in Last Glacial Maximum climates.</i>	2021
Co-mentor, Ekaterina Lezine, SOARS Intern <i>Project: Improving error estimates in SWOOSH.</i>	2018
Instructor of ATS351: Introduction to Weather and Climate (Lab) <i>Independently taught 2.5 hours of class time per week to non-atmospheric science undergraduate majors. Prepared presentations, in-class exercises, and guided demonstrations including spin tank experiments. Created and graded homework problem sets. Topics included weather systems, climate, and climate change with a focus on basic physics.</i>	2015
Teaching assistant for ATS655: Objective Analysis <i>Graded homework, maintained class website. Topics included basic statistical analysis including regression, significance, and EOF analysis.</i>	2014
Assistant and experiment facilitator for CMMAP Teachers' Workshop <i>Trained primary school teachers in weather and climate education. Demonstrated scientifically-accurate, age-appropriate classroom experiments and gave teachers sufficient background knowledge to create or improve their own weather and climate course.</i>	2014
Co-mentor, Bryce Curry, CMMAP Intern <i>Project: “Boundary Hunting in the Tropics”</i>	2014
Teaching assistant for ATS602: Dynamics II <i>Graded homework and exams, created homework, integrated scientific programming. Topics included quasigeostrophic theory, barotropic and baroclinic instability, and wave-mean flow dynamics.</i>	2013
Co-mentor, Aaron Match, CMMAP Intern <i>Project: “Dynamically Motivating the Definition of Sudden</i>	2013

Stratospheric Warmings".

Co-mentor, Steven Brey, CMMAP Intern

2012

Project: "Distinguishing Tropical and Extratropical Dynamical Regimes"