

Nicholas A. Davis

Scientist I
nadavis@ucar.edu
303-497-1409

Atmospheric Chemistry Observations and Modeling
National Center for Atmospheric Research
P.O. Box 3000
Boulder, Colorado 80307-3000 USA

Research Summary

I use models, reanalyses, and observations to study variability and change in the Hadley cells, the Brewer-Dobson circulation, and Rossby wave dynamics. My approach to these topics includes the development of new modeling techniques, including dynamical core modifications and new specified dynamics schemes. I use independent observations to constrain model behavior, but also use models and reanalyses to develop observational diagnostics.

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 develop a more comprehensive, predictive understanding of the general circulation of the atmosphere and its interaction with waves. I am also assisting in the assessment and development of a regionally-refined chemistry climate model, and am continuing to develop new methods for the idealized modeling of the atmosphere.

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., T. Birner, C. O. Ao, O. Verkhoglyadova (2019), Planetary-scale wave generation on the extratropical tropopause in winter observed from COSMIC GPS-RO, in preparation.

Davis, N. A. and T. Birner, A decomposition of the eddy and mean flow responses to forcings: Hadley cell expansion, in preparation.

Staten, P. W., K. M. Grise, S. M. Davis, K. B. Karlsruhkas, 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 (2019), Tropical widening: from global variations to regional impacts, *Bull. Amer. Meteor. Soc.*, submitted.

Davis, N. A., R. W. Portmann, S. M. Davis, P. Yu, E. Ray, and K. Rosenlof, An assessment of specified dynamics schemes in CESM-WACCM, *Global Mod. Dev.*, in review.

Staten, P., K. M. Grise, S. Davis, K. Karlsruhkas, **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.

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

- 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.
- 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

- | | |
|---|-----------|
| 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- |
| 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- |
| 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</i> | 2017-2018 |

² Non-refereed

edge latitudes.

Program Committee, 19th AMS Conference on the Middle Atmosphere <i>Judged abstracts, co-developed conference program, session chair.</i>	2016-2017
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-
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 Young Scientist Symposium on Atmospheric Research, managed approximately \$10,000 in student technology funds per year.</i>	2012-2014
CSU Engineering Student Technology Committee representative <i>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.</i>	2012-2014

Seminars and Invited Talks

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

The Batsheva de Rothschild Seminar on Climate and Wave Dynamics, Eilat, Israel.

“Hadley cell expansion: separating eddy and mean flow responses to forcings.”

CESM Summer 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

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

Teaching and Outreach

Co-mentor, Ekaterina Lezine, SOARS Intern	2018
<i>Project: Improving error estimates in SWOOSH.</i>	
Instructor of ATS351: Introduction to Weather and Climate (Lab)	2015
<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>	
Teaching assistant for ATS655: Objective Analysis	2014
<i>Graded homework, maintained class website. Topics included basic statistical analysis including regression, significance, and EOF analysis.</i>	
Assistant and experiment facilitator for CMMAP Teachers' Workshop	2014
<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>	
Co-mentor, Bryce Curry, CMMAP Intern	2014
<i>Project: "Boundary Hunting in the Tropics"</i>	
<i>Currently a Ph.D. student at Montana State University.</i>	
Teaching assistant for ATS602: Dynamics II	2013
<i>Graded homework and exams, created homework, integrated scientific programming. Topics included quasigeostrophic theory, barotropic and baroclinic instability, and wave-mean flow dynamics.</i>	
Co-mentor, Aaron Match, CMMAP Intern	2013
<i>Project: "Dynamically Motivating the Definition of Sudden Stratospheric Warmings"</i>	
<i>Currently a Ph.D. student at Princeton University.</i>	
Co-mentor, Steven Brey, CMMAP Intern	2012
<i>Project: "Distinguishing Tropical and Extratropical Dynamical Regimes"</i>	
<i>Currently a Ph.D. student at Colorado State University.</i>	