

(Updated 3/19/2025)

Curriculum Vitae of Dr. Zachary Butterfield
butter48@msu.edu

Education

- **Ph.D., Atmospheric, Oceanic and Space Sciences;** University of Michigan, Ann Arbor, MI; 2021
Dissertation: A Multi-Scale Assessment of Solar-Induced Chlorophyll Fluorescence and Its Relation to Northern Hemisphere Forest Productivity
- **M.S., Atmospheric, Oceanic and Space Sciences;** University of Michigan, Ann Arbor, MI; 2017
- **B.S., Physics;** Utah State University, Logan, UT; 2013

Professional Experience

- **Research Associate** (March 2025 – Present)
Geography, Environment, and Spatial Sciences, Michigan State University
Ecological Remote Sensing & Modeling Group
Advisor: Kyla Dahlin
- **Graduate Research Assistant** (July 2014 – June 2021)
Climate and Space Sciences and Engineering, University of Michigan
Carbon Cycle Research Group
Advisor: Gretchen Keppel-Aleks
- **Undergraduate/Post-Bacc Research Assistant** (May 2012 – June 2014)
Earth and Environmental Science, Los Alamos National Laboratory
Advisor: Manvendra Dubey
- **Undergraduate Research Assistant** (January 2011 – May 2013)
Center for Atmospheric and Space Sciences, Utah State University
Sodium LIDAR Research Group
Advisor: Titus Yuan

Publications

- **Z. Butterfield**, T.S. Magney, K. Grossmann, G. Bohrer, C.S. Vogel, S. Barr, G. Keppel-Aleks, *Accounting for changes in radiation improves the ability of SIF to track water stress-induced losses in summer GPP in a temperate deciduous forest*, *Journal of Geophysical Research: Biogeosciences* (2023)
- W. Weider, **Z. Butterfield**, K. Lindsay, D.L. Lombardozzi, G. Keppel-Aleks, *Interannual and seasonal drivers of carbon cycle variability represented by the Community Earth System Model (CESM2)*, *Global Biogeochemical Cycles* (2021)
- B. Byrne, J. Liu, A.A. Bloom, K.W. Bowman, **Z. Butterfield**, J. Joiner, G. Keppel-Aleks, N. Parazoo, Y. Yin, *Contrasting regional carbon cycle*

responses to seasonal climate anomalies across the east-west divide of temperate North America, Global Biogeochemical Cycles (2020)

- **Z. Butterfield**, W. Buermann, G. Keppel-Aleks, *Satellite observations reveal seasonal redistribution of northern ecosystem productivity in response to interannual climate variability*, Remote Sensing of Environment (2020)
- P. Zhu, S.J. Cheng, **Z. Butterfield**, G. Keppel-Aleks, A.L. Steiner, *The Global Influence of Cloud Optical Thickness on Terrestrial Carbon Uptake*, Earth Interactions (2019)
- X. Liu, L.G. Huey, R.J. Yokelson, V. Selimovic, I.J. Simpson, M. Müller, J.L. Jimenez, P. Campuzano-Jost, A.J. Beyersdorf, D.R. Blake, **Z. Butterfield**, Y. Choi, J.D. Crouse, D.A. Day, G.S. Diskin, M.K. Dubey, E. Fortner, T.F. Hanisco, W. Hu, L.E. King, L. Kleinman, S. Meinardi, T. Mikoviny, T.B. Onasch, B.B. Palm, J. Peischl, I.B. Pollack, T.B. Ryerson, G.W. Sachse, A.J. Sedlacek, J.E. Shilling, S. Springston, J.M. St. Clair, D.J. Tanner, A.P. Teng, P.O. Wennberg, A. Wisthaler, G.M. Wolfe, *Airborne measurements of western US wildfire emissions: Comparison with prescribed burning and air quality implications*, Journal of Geophysical Research: Atmospheres (2017)
- S. Collier, S. Zhou, T.B. Onasch, D.A. Jaffe, L. Kleinman, A.J. Sedlacek, N.L. Briggs, J. Hee, E. Fortner, J.E. Shilling, D. Worsnop, R.J. Yokelson, C. Parworth, X. Ge, J. Xu, **Z. Butterfield**, D. Chand, M.K. Dubey, M. S. Pekour, S. Springston, Q. Zhang, *Regional influence of aerosol emission from wildfires driven by compustion efficiency: Insights from the BBOP campaign*, Environmental Science & Technology (2016)
- K. Minschwaner, G. L. Manney, I. Petropavlovskikh, L. A. Torres, Z. D. Lawrence, B. Sutherland, A.M. Thompson, B.J. Johnson, **Z. Butterfield**, M. K. Dubey, L. Froidevaux, A. Lambert, W.G. Read, *Signature of a tropical Pacific cyclone in the composition of the upper troposphere over Socorro, NM*, Geophysical Research Letters (2015)
- R. Lindenmaier, M. Dubey, B. Henderson, **Z. Butterfield**, J. Herman, T. Rahn, S. Lee, *Multi-scale observations of CO₂, ¹³CO₂, and pollutants in Four Corners for emission verification and attribution*, Proceedings of the National Academy of Sciences (2014)

Presentations

- **Z. Butterfield**, S. Barr, C.S. Vogel, T.S. Magney, K. Grossman, G. Bohrer, G. Keppel-Aleks, *Intraseasonal dynamics and directional dependencies in novel tower-based SIF observations over a temperate deciduous forest*, AGU Fall Meeting, San Francisco, CA (2019) (Poster)
- G. Keppel-Aleks, **Z. Butterfield**, S. Basile, Y. Guan, S.C. Doney, W. Buermann, *Quantifying land and ocean carbon cycle responses to climate variability using Earth system satellite observations*, AGU Fall Meeting, San Francisco, CA (2019) (Co-Author)
- **Z. Butterfield**, W. Buermann, G. Keppel-Aleks, *Remote sensing observations of northern forest ecosystems reveal interannual and intraseasonal carbon-*

- climate feedbacks*, Chapman Conference on Understanding Carbon Cycle Feedbacks, San Diego, CA (2019) (Poster)
- G. Keppel-Aleks, **Z. Butterfield**, S. Basile, W. Buermann, S.C. Doney, W.R. Wieder, *Diagnosing regional drivers of carbon cycle interannual variability from atmospheric CO₂*, Chapman Conference on Understanding Carbon Cycle Feedbacks, San Diego, CA (2019) (Co-Author)
 - **Z. Butterfield**, S. Barr, G. Keppel-Aleks, *PhotoSpec: A 2D scanning spectrometer for Solar-Induced chlorophyll Fluorescence (SIF)*, UMBS Winter Meeting, Ann Arbor, MI (2019) (Talk)
 - **Z. Butterfield**, G. Keppel-Aleks, W. Buermann, *Decomposing patterns of interannual variability in remote sensing vegetation data*, AGU Fall Meeting, Washington, D.C. (2018) (Poster)
 - **Z. Butterfield**, S. Barr, G. Keppel-Aleks, *PhotoSpec Observations at the University of Michigan Biological Station*, OCO-2 Science Team Meeting, Boulder, CO (2018) (Co-Author)
 - G. Keppel-Aleks, **Z. Butterfield**, S.C. Doney, E.J. Dlugokencky, J. Miller, D. Morton, *Quantifying the impact of El Niño-driven variations in temperature and precipitation on regional atmospheric CO₂ growth rate variations*, AGU Fall Meeting, New Orleans, LA (2017) (Co-Author)
 - **Z. Butterfield**, A. Hogikyan, S. Kulawik, G. Keppel-Aleks, *Satellite-derived SIF and CO₂ Observations Show Coherent Responses to Interannual Climate Variations*, AGU Fall Meeting, New Orleans, LA (2017) (Talk)
 - **Z. Butterfield**, G. Keppel-Aleks, *Satellite-derived SIF observations show coherent response to climate variations*, OCO-2 Science Team Meeting, Boulder, CO (2017) (Poster)
 - G. Keppel-Aleks, **Z. Butterfield**, A. Hogikyan, E. Gargulinski, *Separating temperature- and moisture-driven variations in terrestrial carbon uptake using multiple remote sensing constraints*, International Carbon Dioxide Conference, Interlaken, Switzerland (2017) (Co-Author)
 - S. Cheng, P. Zhu, G. Keppel-Aleks, **Z. Butterfield**, A.L. Steiner, *The Global Influence of Cloud Optical Thickness on Terrestrial Carbon Uptake*, AGU Fall Meeting, San Francisco, CA (2016) (Co-Author)
 - **Z. Butterfield**, G. Keppel-Aleks, *Using Chlorophyll Fluorescence to Assess the Impact of Agriculture on Northern Hemisphere CO₂ Seasonality*, AGU Fall Meeting, San Francisco, CA (2015) (Poster)
 - **Z. Butterfield**, R. Lindenmaier, M. Dubey, J. Hedelius, D. Wunch, P. Wennberg, J. Podolske, L. Iraci, F. Hase, P. Hillyard, *Compact Solar Spectroscopic Column CO₂, CH₄, H₂O and HDO Observations: Performance Evaluation at TCCON Sites*, AGU Fall Meeting, San Francisco, CA (2014) (Poster)
 - **Z. Butterfield**, M. Dubey, R. Lindenmaier, J. Herman, P. Disterhoft, K. Minschwaner, *Total Column Observation of Nitrogen Dioxide and Ozone in the Four Corners Region*, AGU Fall Meeting, San Francisco, CA (2013) (Poster)

- **Z. Butterfield**, M. Dubey, R. Lindenmaier, J. Herman, *Multi-Scale Observation of Nitrogen Dioxide and Ozone in the Four Corners Region*, LANL Annual Student Symposium, Los Alamos, NM (2013) (Talk)
- R. Lindenmaier, M. Dubey, **Z. Butterfield**, J. Herman, C. Arata, B. Henderson, T. Rahn, *Column and In Situ CO₂, ¹³CO₂, CO, and NO₂ Increases by Power Plants: New Constraints on Emissions*, AGU Fall Meeting, San Francisco, CA (2012) (Co-Author)
- M. Dubey, R. Lindenmaier, B. Henderson, K. Costigan, S. Lee, J. Herman, S. Love, T. Rahn, C. Arata, **Z. Butterfield**, P. Chylek, J. Reisner, W. Porch, *Multi-Scale Measurements and Modeling of Greenhouse Gas and Pollutant Emissions from Coal Power Plants and Gas Mining at Four Corners*, AGU Fall Meeting, San Francisco, CA (2012) (Co-Author)
- **Z. Butterfield**, M. Dubey, R. Lindenmaier, *Multi-Scale Observation of Nitrogen Dioxide in the Four Corners Region*, LANL Annual Student Symposium, Los Alamos, NM (2012) (Talk; Outstanding Presentation in Earth and Space Science)
- **Z. Butterfield**, B. Bostrom, X. Cai, and T. Yuan, *Studying the Upper Atmosphere Using a Sodium LIDAR*, CEDAR Workshop, Santa Fe, NM (2012) (Poster)
- **Z. Butterfield**, B. Bostrom, X. Cai, T. Yuan, *Studying the Upper Atmosphere Using a Sodium LIDAR*, APS Four Corners Section Meeting, Tucson, AZ (2011) (Poster)

Data Sets

- **Z. Butterfield**, D. Muccio, G. Keppel-Aleks, (2022). Tower observations of solar-induced chlorophyll fluorescence at the University of Michigan Biological Station, University of Michigan - Deep Blue Data
- M. Dubey, B. Henderson, D. Green, **Z. Butterfield**, G. Keppel-Aleks, N. Allen, J.-F. Blavier, C. Roehl, D. Wunch, R. Lindenmaier, (2014). TCCON data from Manaus (BR), Release GGG2014. R0
- M. Dubey, R. Lindenmaier, B. Henderson, D. Green, N. Allen, C. Roehl, J.-F. Blavier, **Z. Butterfield**, S. Love, J. Hamelmann, D. Wunch, (2014). TCCON data from Four Corners (US), Release GGG2014. R0

Honors and Awards

- 2015 – Honorable Mention, Graduate Research Fellowships Program, National Science Foundation
- 2014 – Rackham Engineering Award, Rackham Merit Fellowship Program, University of Michigan
- 2014 – Dean’s Fellowship, Department of Atmospheric and Oceanic Sciences, University of Colorado Boulder (declined)
- 2013 – Outstanding Graduating Seniors Award, Department of Physics, Utah State University

- 2012 – College of Science Scholarship, College of Science, Utah State University
- 2012 – Charles D. and Leah F. Hendricks Scholarship, Department of Physics, Utah State University
- 2010 – Presidential Transfer Scholarship, Utah State University

Organization Memberships and Leadership Experience

- American Geophysical Union
- Michigan Geophysical Union Symposium (Committee Member—2016-2020; Committee Chair—2019)
- Sigma Pi Sigma (Chapter Vice President—2011-2012)
- American Physical Society

Journal Reviewer

- Remote Sensing of Environment; Journal of Hydrology

Teaching experience

- CEE 575, *Sensors, Data, and Intelligent Systems*, University of Michigan (Grader, Winter 2017)
- AOSS 473, *Climate Physics*, University of Michigan (Grader, Fall 2015)
- PHYS 2210/2220, *General Physics*, Utah State University (Recitation Instructor, Fall 2011 – Spring 2013)
- PHYS 2210, *General Physics*, Utah State University (Lab Instructor, Spring 2011)

Skills

- Software and Coding: Python, MATLAB, IGOR Pro, MS Office

Graduate-level Courses Taken

- CEE 575, *Sensors, Data, and Intelligent Systems*, University of Michigan
- AOSS 551, *Fluid Dynamics*, University of Michigan
- AOSS 466, *Carbon-Climate Interactions*, University of Michigan
- AOSS 605, *Data Assimilation*, University of Michigan
- AOSS 532, *Radiative Transfer*, University of Michigan
- AOSS 473, *Climate Physics*, University of Michigan
- AOSS 411, *Cloud and Precipitation Processes*, University of Michigan
- AOSS 479, *Atmospheric Chemistry*, University of Michigan
- AOSS 451, *Atmospheric Dynamics*, University of Michigan