

R. R. Buchholz

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Qualifications:

- PhD, The University of Wollongong, Australia (UOW) 2014
*Tropospheric Composition in the Southern Hemisphere,
Investigated with Spectroscopic Measurements and Global Models*
- BSc. (Hons. I) Chemistry, The University of Queensland, Australia (UQ) 2007
Analogues of Bacterial Phosphoesterases
- BSc./BA, The University of Queensland, Australia (UQ) 2006
Chemistry, Biological Chemistry, Mathematics (double major)

Research Experience:

- Project Scientist I, National Center for Atmospheric Research, USA 2017–current
Postdoctoral Researcher, National Center for Atmospheric Research, USA 2014–2017
Honorary Postdoctoral Research Associate, UOW 2015–2016
Research Assistant (RA), Centre for Atmospheric Chemistry, UOW 2013–2014
RA, Emphron Informatics Pty. Ltd., Brisbane 2009
RA, Gahan inorganic chemistry laboratory, UQ 2007–2009

Supervision Experience:

- Masters and PhD student mentoring
- William Daniels, Colorado School of Mines, CO 2019-2021
Osinachi Ajoku, Scripps Institution of Oceanography, CA 2019
- Undergraduate internship for credit
- Peizhi Hao, University of Colorado, CO 2021
Thomas Sullivan, University of Colorado, CO 2020
- Research Mentor for undergraduate student, SOARS program, NCAR
- Isabel Albores, Williams College 2021
- Writing Mentor for four undergraduate students, SOARS program, NCAR
- Ekaterina Lezine, University of North Carolina at Chapel Hill 2019
Starlette Williams, University of Oklahoma 2018
Jordan Benjamin, Massachusetts Institute of Technology 2017
Briah' Davies, University at Albany SUNY 2016
- Summer Intern Research Co-Mentor:
- ACOM, Janyl Madykova, Texas Southern University masters student 2020
ACOM & CISL, Peter Simonson, CO School of Mines graduate student 2018
ACOM, Holden Leslie-Bole, Yale undergraduate 2017
- Experimental and research co-supervision for undergraduate RAs, UQ 2007–2009
- Morgan Etienne, Anneke Dorgelo, Shiao Chow

Teaching Roles:

Head Demonstrator, first year Chemistry, UOW	2014
POGIL tutor in first year Chemistry, UOW	2012–2014
Demonstrating first and second year Chemistry, UOW	2010–2013
Mathematics Tutor, UQ and UOW	2007, 2010
Academic Supervisor, Chemistry Peer Assisted Study Sessions, UQ	2007–2009

Competitive Grants Awarded:

S. Tilmes, and 7 others including <u>R. Buchholz</u> (Co-PI). Climate and air quality impacts including an interactive fire model for future climate scenarios with and without geoengineering, Part 2. <i>NCAR Strategic Capability Project</i>	2019–2020
S. Tilmes, and 9 others including <u>R. Buchholz</u> (Co-I). Climate and air quality impacts including an interactive fire model for future climate scenarios with and without geoengineering. <i>NCAR Strategic Capability Project</i>	2018
H. M. Worden, and 11 others including <u>R. Buchholz</u> (Co-I). Multi-decadal record of satellite carbon monoxide observations from Terra/MOPITT to SNPP/CrIS. <i>NASA ROSES 2017 Solicitation: NNH17ZDA001N-TASNPP</i>	2018–2022
L. K. Emmons, and 9 others including <u>R. Buchholz</u> (Co-I). Multi-scale Chemical Forecasting and Analysis for FIREChem. <i>NASA ROSES-2017 Solicitation: NNH17ZDA001N-FIRECHM</i>	2017–2022
L. K. Emmons, and 15 others including <u>R. Buchholz</u> (Co-I). Global and Regional Chemical Forecasting and Analysis using CAM-chem, Data Assimilation and WRF-Chem for KORUS-AQ: An International Cooperative Air Quality Field Study in Korea. <i>NASA ROSES-2015 Solicitation</i>	2015–2018
N. B. Jones (PI) and 6 others including <u>R. Buchholz</u> (Researcher). The use of state-of-the-art 3-D chemical transport modelling to unravel the effects of atmospheric chemistry on climate. Competition for computational resources from the <i>National Computational Merit Allocation Scheme/Intersect</i> , Australia	2012–2013

Refereed Articles and Articles Under Review:

1. Buchholz, R. R., et al, New seasonal pattern of pollution emerges from changing North American wildfires, under review in *Nature Communications*, *December 2020*.
2. Ortega, I., Hannigan, J. W., Buchholz, R. R. and Pfister, G., Long-term variability and source signature of gases emitted from oil & natural gas and cattle feedlot operations in the Colorado front range, *Atmospheric Environment*, doi: 10.1016/j.atmosenv.2021.118663, 2021.
3. Fasullo, J. T., Rosenbloom, N. A., Buchholz, R. R., et al., Coupled Climate Responses to Recent Australian Wildfire and COVID-19 Emissions Anomalies Estimated in CESM2, *GRL*, doi:10.1029/2021GL093841, 2021.
4. Tang, W., Edwards, D. P., Louisa K. Emmons, L. K., Worden, H. M., Judd, L. M., Lamsal, L. N., Al-Saadi, J. A., Janz, S. J., Crawford, J. H., Deeter, M. N., Pfister, G., Buchholz, R.

- R., Gaubert, B., Nowlan, C. R., Assessing sub-grid variability within satellite pixels using airborne mapping spectrometer measurements, *Atmospheric Measurement Techniques*, 2021.
5. Wang, B., Kuang, S., Pfister, G., Biazar, A. P., Newchurch, M., Buchholz R. R. and Langford, A., Impact of the 2016 Southeastern U.S. Wildfires on the Vertical Distribution of Ozone and Aerosol at Huntsville, Alabama, *J. Geophys. Res.-Atmos.*, 2021.
 6. Hedelius, J., Toon, G., Buchholz R. R., et al., Regional and Urban Column CO Trends and Anomalies as Observed by MOPITT Over 16 Years, *J. Geophys. Res.-Atmos.*, 126, e2020JD033967, doi: 10.1029/2020JD033967, 2021.
 7. Buchholz R. R., et al., Air pollution trends measured from Terra: CO and AOD over industrial, fire-prone, and background regions, *Remote Sensing of Environment*, 256, 112275, doi: 10.1016/j.rse.2020.112275, 2021.
 8. Gaubert, B., Emmons, L., Raeder, K., Tilmes, S., Miyazaki, K., Arellano, A., Elguindi, N., Granier, C., Tang, W., Barré, J., Worden, H., Buchholz R. R., Correcting model biases of CO in East Asia: impact on oxidant distributions during KORUS-AQ, *Atmospheric Chemistry and Physics*, doi: 10.5194/acp-2020-599, 2020.
 9. Emmons, L. K., Schwantes, R. H., Orlando, J. J., Tyndall, G., Kinnison, D., Lamarque, J.-F., Marsh, D., Mills, M., Tilmes, S., Bardeen, C., Buchholz R. R., et al., The Chemistry Mechanism in the Community Earth System Model version 2 (CESM2), *Journal of Advances in Modeling Earth Systems*, 12, e2019MS001882, doi: 10.1029/2019MS001882, 2020.
 10. Tang, W., Worden, H. M., Deeter, M. N., Edwards, D. P., Emmons, L. K., Martínez-Alonso, S., Gaubert, B., Buchholz R. R., et al., Assessing Measurements of Pollution in the Troposphere (MOPITT) carbon monoxide retrievals over urban versus non-urban regions, *Atmos. Meas. Tech.*, 13, 1337-1356, doi: 10.5194/amt-13-1337-2020, 2020.
 11. Hedelius, J. K., He, T.-L., Jones, D. B. A., Baier, B. C., Buchholz R. R., et al., Evaluation of MOPITT Version 7 joint TIR–NIR XCO retrievals with TCCON, *Atmos. Meas. Tech.*, 12, 5547–5572, doi: 10.5194/amt-12-5547-2019, 2019.
 12. Matsueda, H., Buchholz R. R., et al., Interannual Variation of Upper Tropospheric CO over the Western Pacific Linked with Indonesian Fires, *SOLA*, 1349-6476, doi: 10.2151/sola.2019-037, 2019.
 13. Guérette, É.-A., Paton-Walsh, C., Galbally, I., Molloy, S., Lawson, S., Kubistin, D., Buchholz R. R., et al., Composition of clean marine air and biogenic influences on VOCs during the MUMBA campaign, *Atmosphere*, 10(7), 383, doi: 10.3390/atmos10070383, 2019.
 14. Ivan Ortega, I., Buchholz R. R., et al., Tropospheric water vapor profiles obtained with FTIR: comparison with balloon-borne frost point hygrometers and influence on trace gas retrievals, *Atmos. Meas. Tech.*, 12, 873–890, doi: 10.5194/amt-12-873-2019, 2019.
 15. Tang, W., Emmons, L. K., Arellano, A. F. Jr., Gaubert, B., Knote, C., Tilmes, S., Buchholz, R. R., et al., Source contributions to carbon monoxide concentrations during KORUS-AQ based on CAM-chem model applications, *J. Geophys. Res.-Atmos.*, 124, doi: 10.1029/2018JD029151, 2019.
 16. Paton-Walsh, C., Guérette, É.-A., Emmerson, K., Cope, M., Kubistin, D., Humphries, R., Wilson, S., Buchholz, R. R., et al., Urban Air Quality in a Coastal City: Wollongong during the MUMBA Campaign, *Atmosphere*, 9, 500, doi: 10.3390/atmos9120500, 2018.

17. Buchholz, R. R., *et al.*, Links between carbon monoxide and climate indices for the Southern Hemisphere and tropical fire regions, *J. Geophys. Res.-Atmos.*, doi: 10.1029/2018JD028438, 2018.
18. Buchholz, R. R., *et al.*, Validation of MOPITT carbon monoxide using ground-based Fourier transform infrared spectrometer data from NDACC, *Atmos. Meas. Tech.*, doi: 10.5194/amt-10-1927-2017, 2017.
19. Paton-Walsh, C., Guérette, É.-A., Kubistin, D., Humphries, R., Wilson, S. R., Rea, G., Shi, X., Griffith, D. W. T., Buchholz, R. R., *et al.*, The MUMBA Campaign: Measurements of urban, marine and biogenic air, *Earth System Science Data*, doi: 10.5194/essd-9-349-2017, 2017.
20. Té, Y., Jeseck, P., Franco, B., Mahieu, E., Jones, N. B., Paton-Walsh, C., Griffith, D. W. T., Buchholz, R. R., *et al.*, Seasonal variability of surface and column carbon monoxide over the megacity Paris, high-altitude Jungfraujoch and Southern Hemispheric Wollongong stations, *Atmos. Chem. Phys.*, 16, pg. 10,911–10,925, doi: 10.5194/acp-16-10911-2016, 2016.
21. Gaubert, B., Arellano, A. F. Jr., Barré, J., Worden, H. M., Emmons, L. K., Tilmes, S., Buchholz, R. R., *et al.*, Towards a chemical reanalysis in a coupled chemistry-climate model: An evaluation of MOPITT CO assimilation and its impact on tropospheric composition, *J. Geophys. Res.-Atmos.*, 121(12), pg. 7310–7343, doi: 10.1002/2016JD024863, 2016.
22. Buchholz, R. R., *et al.*, Source and meteorological influence on air quality (CO, CH₄ & CO₂) at a Southern Hemisphere urban site, *Atmos. Environ.*, 126, pg. 274-289, doi: 10.1016/j.atmosenv.2015.11.041, 2016.
23. Paton-Walsh, C., Guérette, E.-A., Humphries, R., Kubistin, D., Wilson, S., Griffith, D., Buchholz, R. *et al.*, Overview of the instruments deployed during the MUMBA Campaign: Measurements of urban, marine and biogenic air, *Proceedings of the 21st International Clean Air and Environment Conference*, 2013.
24. Kantacha, A., Buchholz, R. R. *et al.*, Phosphate ester cleavage promoted by a tetrameric iron (III) complex, *J. Biol. Inorg. Chem.*, 16, pg. 25–32, doi: 10.1007/s00775-010-0696-0, 2011.
25. Kobe, B., Guncar, G., Buchholz, R., *et al.*, The Many Faces Of Platelet Glycoprotein Iba - Thrombin Interaction, *Curr. Protein Pept. Sc.*, 10, pg. 551–558, 2009.
26. Buchholz R. R., *et al.*, A structural and catalytic model for zinc phosphoesterases, *Dalton Trans.*, 43, pg. 6045–6054, doi: 10.1039/b806391e, 2008.
27. Kobe, B., Guncar, G., Buchholz, R. R. *et al.*, Crystallography and protein-protein interactions: biological interfaces and crystal contacts, *Biochem Soc. Trans.*, 36, pg. 1438–1441, doi: 10.1042/BST0361438, 2008.

Unrefereed Articles:

1. Duggal, M., Daniels, W., Hammerling D., Buchholz, R. R., Optimizing Genetic Algorithm Parameters for Atmospheric Carbon Monoxide Modeling, NCAR Technical Note, doi: 10.5065/h45f-c987, 2021.
2. Daniels, W., Hammerling, D., Buchholz, R. R., regClimateChem: An R Package for Data Driven Variable Selection Applied to Atmospheric Carbon Monoxide, NCAR Technical Note, doi: 10.5065/e8xj-3k89, 2020.

Articles in Preparation:

1. Buchholz R. R., Edwards, D. P., Emmons, L. K., Jones, N. B., Paton-Walsh, C., Deutscher, N. M., Velazco, V. and Griffith, D. W. T., Satellite and ground-based remote sensing of carbon monoxide over Australasia: Linking global and local scales, in preparation for *J. Geophys. Res.-Atmos.*
2. Buchholz R. R., Tang, W., Wiedinmyer, C., Emmons, L.K., Gaubert, B., Lacey, F., Park, M., Tilmes, S., Worden, H., Uncertainty in fire emission factors impacts simulated atmospheric composition: CO and O₃, in preparation for *Earth System Science Data*

Published Datasets:

1. Buchholz, R. R., Worden, H. M., Warner, J., Luo, M., Payne, V. & George, M., Hemispheric and regional monthly average carbon monoxide from satellite instruments. *Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory*. <https://rda.ucar.edu/datasets/ds682.3/>, doi: 10.5065/XVQE-0P52, 2020.
2. Buchholz, R. R., Emmons, L. K., Tilmes, S., & The CESM2 Development Team, CESM2.1/CAM-chem instantaneous output for boundary conditions. *UCAR/NCAR - Atmospheric Chemistry Observations and Modeling Laboratory*, doi: 10.5065/NMP7-EP60, 2019.
3. Buchholz, R. R. and Worden, H. M., Regional Anomalies of MOPITT Satellite-measured Carbon Monoxide, 2001-01-16 to 2016-12-16. *Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory*. <http://rda.ucar.edu/datasets/ds682.0/>, doi: 10.5065/D61N7ZX4, 2017.
4. Buchholz, R. R. and Griffith, D. W. T., Measurements of CO₂, CO, CH₄, N₂O and ¹³C in CO₂ at time series station Wollongong, 2012–12–21 to 2013–02–15. *PANGAEA Data Publisher for Earth & Environmental Science*, doi: 10.1594/PANGAEA.871986, 2017.
5. Guérette, E.-A., Paton-Walsh, C., Kubistin, D., Humphries, R., Bhujel, M., Buchholz, R. R. et al., Measurements of Urban, Marine and Biogenic Air (MUMBA): characterisation of trace gases and aerosol at the urban, marine and biogenic interface in summer in Wollongong, Australia. *PANGAEA Data Publisher for Earth & Environmental Science*, doi: 10.1594/PANGAEA.871982, 2017.
6. Buchholz, R. R. et al., Surface in situ measurements of atmospheric CO, CH₄, and CO₂ combined with selected meteorological measurements at the University of Wollongong, Australia. *PANGAEA Data Publisher for Earth & Environmental Science*, doi: 10.1594/PANGAEA.848263, 2015.

Presentations as First Author (Last 5 years):

1. North American Wildfires are Changing the Atmospheric Carbon Monoxide Seasonal Cycle, poster at *American Geophysical Union Fall Meeting*, Virtual, USA, Dec., 2020.
2. Fire Impact on Large-Scale Properties of Atmospheric Composition: CO & AOD, invited talk at *The University of Wollongong Center for Atmospheric Chemistry*, Weekly Research Meeting - Virtual, Oct., 2020.
3. Air pollution trends: CO and AOD over industrial, fire-prone, and background regions, invited talk at *AIRS Science Team Meeting*, NASA Virtual Teleconference, May, 2020.

4. The effect of fire emission factor uncertainty on global chemistry simulations, talk at *The 3rd International Smoke Symposium (ISS3)*, International Association of Wildland Fire Virtual Teleconference, Apr., 2020.
5. How fire emission factor uncertainty relates to inter-inventory differences in modeled atmospheric composition, talk at *Joint Winter Meeting of CESM Atmosphere Model, Whole Atmosphere and Chemistry-Climate Working Groups*, Boulder, USA, Mar., 2020.
6. Terra Trends: A Global Slowdown in Decreasing Atmospheric CO and the Regional Interpretation Using AOD, poster at *American Geophysical Union Fall Meeting*, San Francisco, CA, USA, Dec., 2019.
7. Using CAM-chem to interpret carbon monoxide variability in the Southern Hemisphere, poster at *24th Annual Community Earth System Model workshop*, Boulder CO, USA, Jun., 2019.
8. Transported and local contributions to carbon monoxide in tropical north Australia, talk at *AMOS Annual Meeting and the International Conference on Tropical Meteorology and Oceanography*, Darwin, Australia, Jun. 2019.
9. Validation of MOPITT CO using ground-based solar FTIR measurements in NDACC, talk at *Joint NDACC-IRWG and TCCON Meeting*, Wanaka, New Zealand, May 2019.
10. Chemistry-Climate Links for Carbon Monoxide in Northern Hemisphere Boreal Fire Regions and an Assessment of Global Fire Inventories, poster (presented by H. Worden) *American Geophysical Union Fall Meeting*, Washington D.C., USA, doi: 10.1002/essoar.10500487.1, Dec., 2018.
11. Transported and local contributions to carbon monoxide in Australasia, poster at *joint 14th iCACGP Symposium and 15th IGAC Science Conference*, Takamatsu, Kagawa, Japan, Sep., 2018.
12. The effect of variability in fire emission factors on inter-inventory differences, talk at *23rd Annual Community Earth System Model workshop*, Boulder CO, USA, Jun., 2018.
13. Climate mode links to atmospheric carbon monoxide over fire regions, talk at *American Geophysical Union Fall Meeting*, New Orleans, USA, Dec., 2017.
14. Predicting atmospheric carbon monoxide over fire regions using climate indices, talk at *Fire Prediction Across Scales Conference*, Columbia University, New York City, USA, Oct., 2017.
15. Temporal evolution of C₂H₆ to CO enhancement ratios, extended globally using MOPITT CO, poster at *Infrared Working Group Meeting*, Paris, France, May, 2017.
16. Linking variability of atmospheric carbon monoxide to climate modes in the Southern Hemisphere, poster at *European Geosciences Union General Assembly*, Vienna, Austria, Apr., 2017.
17. Assessing the link between climate variability and atmospheric carbon monoxide in the Southern Hemisphere, talk at *Australasian weather, climate and oceans: past, present and future: AMOS/MSNZ Annual Conference and ANZ Climate Forum*, Canberra, Australia, Feb. 2017.
18. Climate drivers of Southern Hemisphere carbon monoxide, talk at *One Atmosphere: Building a collective knowledge, International Global Atmospheric Chemistry Biennial Conference*, Breckenridge, USA, Sep. 2016.

19. Investigating transported and local carbon monoxide in the Southern Hemisphere with satellite and ground-based remote sensing, talk at *Mario J. Molina Symposium, in the 96th American Meteorological Society Annual Meeting*, New Orleans, USA, Jan. 2016

Honors and Awards:

NASA Group Achievement Award to FIREX-AQ	2020
NASA Pecora Award for outstanding contributions: Terra Team	2019
Columbia University travel support, Fire Prediction Conference	2017
NASA Group Achievement Award to KORUS-AQ	2017
Mario J. Molina Symposium early career travel grant	2016
UOW postgraduate travel grant, Aveiro summer school	2014
UOW postgraduate travel grant, NCAR visit	2013
CSIRO OCE postgraduate (PhD) top-up Scholarship	2011–2013
Australian Postgraduate Award (APA)	2010–2013
Harvard travel grant, GEOS-Chem conference	2011, 2013
AMOS best student presentation, Extreme Weather conference	2011
Dean's commendation for high achievement: UQ	2001, 2003–2006

Reviewer:

Advances in Atmospheric Sciences; Atmosphere; Atmospheric Chemistry and Physics; Atmospheric Environment; Atmospheric Measurement Techniques; Atmospheric Research; Journal of Environmental Informatics; Journal of Geophysical Research - Atmospheres; Applied Geochemistry; Environmental Pollution; NCAR internal review; Remote Sensing; Science of the Total Environment

Service, Leadership and Public Engagement:

Grand Awards Judge, Colorado Science and Engineering Fair	2015–2021
NSF Reviewer	2021
Mentor for a Cherry Creek High School Research Project	2019–2020
Outstanding Student Presentation Awards Judge, AGU Fall Meeting	2015, 2017, 2019, 2020
Organizing Committee, NCAR/ACOM FASCINATE Workshop	2019
Breakout group facilitator, NCAR Atmospheric Modeling Workshop	2018
Job Shadow Host for a Freshman at Wheat Ridge High School	2018
Mentor, Colorado Front Range undergraduate support program (PROGRESS)	2017–2018
Denver ComicCon panelist, NASA Women in Science	2018
Member, NCAR Innovation Council advisory group	2017–2018
Student Poster Judge, European Geosciences Union General Assembly	2017
Student Poster Judge, Earth System & Space Science Poster Conference, CU	2014, 2015, 2017
Session convenor: “Atmospheric and oceanic composition” at the AMOS/MSNZ Annual Conference and ANZ Climate Forum	2017
Workshop presenter, Girls Exploring STEM, Denver, Colorado	2015–2017
Science Experience for High School Students, UOW	2011

Professional Development/Supplementary Qualifications:

NCAR Leadership Academy	<i>2019</i>
NCAR Grant Development Workshop,	<i>2018</i>
Introduction to Bayesian Statistics, NCAR	<i>2016</i>
CIRTL Associate, Colorado University teaching workshop (STRIPE)	<i>2016</i>
UNEION (UCAR NCAR Equity and InclusiON) training	<i>2016</i>
NSF Geosciences Postdoctoral Career Development Workshop, NCAR	<i>2016</i>
JPL Summer School: Using Satellite Observations to Advance Climate Models	<i>2015</i>
CESM tutorial, NCAR	<i>2015</i>
Denial 101x: Making sense of climate science denial (EdX online course)	<i>2015</i>
Integrated Modelling Summer School, Aveiro, Portugal	<i>2014</i>
European Research Course on Atmospheres, Grenoble, France	<i>2012</i>
Gas Cylinder Handling Course, UOW	<i>2012</i>
Liquid Nitrogen Safe Handling Course, UOW	<i>2010</i>

Professional Affiliations:

Clean Air Society of Australia and New Zealand (CASANZ)	<i>2013–current</i>
American Geophysical Union (AGU)	<i>2011–current</i>
International Global Atmospheric Chemistry (IGAC)	<i>2011–current</i>
Australian Meteorological & Oceanographic Society (AMOS)	<i>2010–current</i>
American Chemical Society (ACS)	<i>2009–current</i>