Sarah A. Strode

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RESEARCH INTERESTS: Atmospheric chemical transport and chemistry climate modeling, earth system modeling, trace gas emissions, methane, biogeochemical cycling and interactions between the atmosphere and the biosphere and ocean, air quality, atmospheric composition, global change

EDUCATION:

Ph.D.: Atmospheric Sciences; University of Washington, Seattle, WA (2008)
Dissertation Topic: "Mercury in the Atmosphere and Ocean: Sources, Transport, and Global Impacts"
Advisor: Lyatt Jaeglé

M.S.: Atmospheric Sciences; University of Washington, Seattle, WA (2005)
Advisor: Lyatt Jaeglé

B.A.: Chemistry and Mathematics, Washington University in St. Louis, St. Louis, MO (2002)

AWARDS:

Outstanding Performance Award from NASA GMAO (2011)
University of Washington Program on Climate Change fellowship (2002)
ARCS Foundation fellowship (2002-2004)

RESEARCH EXPERIENCE:

Scientist, Earth Sciences, Universities Space Research Association (8/11-present)

- Led the GMI chemical transport modeling effort for NASA's Atmospheric Tomography Mission (ATom) and provided forecasting for ATom
- Investigates trends and variability in atmospheric composition by using models to analyze satellite, surface, and suborbital observations
- Evaluates model performance and contributes to model intercomparison projects (ACCMIP, CCMI)
- Contributes to development of the atmospheric chemistry components of the GEOS model

Atmospheric Constituent Scientist, Science Applications International Corporation (9/09-8/11)
Topic: Trace gas simulation with the GEOS5 chemistry climate model

- Contributed to GMAO's earth system modeling: evaluated model performance with satellite, aircraft, and surface observations
- Updated trace gas emissions for the GEOS5 CCM

Research Assistant, University of Washington (9/02-6/08)
Topic: Simulation of mercury with GEOS-Chem global chemical transport model
Advisor: Lyatt Jaeglé

- Coupled slab model of ocean to atmospheric mercury code
- Compared model to observations and attributed sources of long-range transport
- Developed simple model of vertical transport of mercury in the ocean

Carnegie Institute of Washington Geophysical Laboratory, Research Experience for Undergraduates program (6/02-8/03)
Topic: Winogradsky columns as microcosms of natural sediments
Advisor: James Scott

- Collected natural sediments
- Analyzed isotopes in a sediment column

WORK EXPERIENCE:

Environmental Consultant (7/08-6/09)

- Developed greenhouse gas inventories for university and industry clients
- Contributed to human health risk assessments

TEACHING EXPERIENCE:

Teaching Assistant, University of Washington (Winter 2004, Autumn 2006)
Led discussion sections, prepared and graded homework and exams, held office hours
ATMS 101: "Weather"
ATMS 212: "Air Pollution: from urban smog to the ozone hole"

PUBLICATIONS:

DeLang, M. N., et al (2021). Mapping Yearly Fine Resolution Global Surface Ozone through the Bayesian Maximum Entropy Data Fusion of Observations and Model Output for 1990–2017. *Environmental Science & Technology*, *55*(8), 4389-4398. doi: 10.1021/acs.est.0c07742.

Keller, C. A., et al. (2021). Description of the NASA GEOS composition forecast modeling system GEOS-CF v1.0. *Journal of Advances in Modeling Earth Systems*, 13, e2020MS002413. https://doi.org/10.1029/2020MS002413

Strode, S.A., Wang, J.S., Manyin, M., Duncan, B., Hossaini, R., Keller, C.A., Michel, S.E. and White, J.W. (2020), Strong sensitivity of the isotopic composition of methane to the plausible range of tropospheric chlorine. *Atmos. Chem. Phys.*, *20*(14), 8405-8419, doi:10.5194/acp-20-8405-2020.

Gaudel, A., Cooper, O.R., Chang, K.L., Bourgeois, I., Ziemke, J.R., **Strode, S.A.**, Oman, L.D., Sellitto, P., Nédélec, P., Blot, R. and Thouret, V. (2020), Aircraft observations since the 1990s reveal increases of tropospheric ozone at multiple locations across the Northern Hemisphere. *Science Advances*, *6*(34), p.eaba8272, doi: 10.1126/sciadv.aba8272.

Kerr, G. H., Waugh, D. W., Steenrod, S. D., **Strode, S. A.**, & Strahan, S. E. (2020). Surface ozone-meteorology relationships: Spatial variations and the role of the jet stream. *Journal of Geophysical Research: Atmospheres*, 125, e2020JD032735. https://doi.org/10.1029/2020JD032735

Kuai, L. et al. (2020), Attribution of Chemistry-Climate Model Initiative (CCMI) ozone radiative flux bias from satellites, *Atmos. Chem. Phys., 20,* 281-301, doi: 10.5194/acp-20-281-2020.

Liu, F., Page, A., **Strode, S.A.**, Yoshida, Y., Choi, S., Zheng, B., Lamsal, L.N., Li, C., Krotkov, N.A., Eskes, H. and Veefkind, P. (2020), Abrupt decline in tropospheric nitrogen dioxide over China after the outbreak of COVID-19. *Science Advances*, 6(28), p.eabc2992, doi:10.1126/sciadv.abc2992.

Wang, J. S., Oda, T., Kawa, S. R., **Strode, S. A.**, Baker, D. F., Ott, L. E., and S. Pawson (2020), The impacts of fossil fuel emission uncertainties and accounting for 3-D chemical CO_2 production on inverse natural carbon flux estimates from satellite and in situ data, *Environ. Res. Lett., 15,* doi:10.1088/1748-9326/ab9795.

Zhao, Y. et al. (2020), On the role of trend and variability in the hydroxyl radical (OH) in the global methane budget, Atmos. Chem. Phys., 20, 13011–13022, doi: 10.5194/acp-20-13011-2020.

Strode, S.A., J.R. Ziemke, L.D. Oman, L.N. Lamsal, M.A. Olsen, J. Liu (2019), Global changes in the diurnal cycle of surface ozone, *Atmos. Environ., 199*, 323-333, doi:10.1016/j.atmosenv.2018.11.028.

Kerr, G. H., Waugh, D. W., **Strode, S. A.**, Steenrod, S. D., Oman, L. D., & Strahan, S. E. (2019). Disentangling the drivers of the summertime ozone-temperature relationship over the United States. *J. Geophys. Res. Atmos.*, *124*, 10503–10524. https://doi.org/10.1029/2019JD030572.

Zhao, Y. et al. (2019), Inter-model comparison of global hydroxyl radical (OH) distributions and their impact on atmospheric methane over the 2000-2016 period, *Atmos. Chem. Phys., 19,* 13701-13723, doi:10.5194/acp-19-13701-2019.

Ziemke, J.R., L.D. Oman, **S.A. Strode**, A.R. Douglass, et al. (2019), Trends in global tropospheric ozone inferred from a composite record of TOMS/OMI/MLS/OMPS satellite measurements and the MERRA-2 GMI simulation , *Atmos. Chem. Phys., 19*, 3257-3269, doi:10.5194/acp-19-3257-2019.

Hall, S.R. et al. (2018), Cloud impacts on photochemistry: building a climatology of photolysis rates from the Atmospheric Tomography mission, *Atmos. Chem. Phys., 18*, 16809–16828, doi:10.5194/acp-18-16809-2018.

Nicely, J.M., T.P. Canty, M. Manyin, L.D. Oman, R.J. Salawitch, S.D. Steenrod, S.E. Strahan and **S.A. Strode** (2018), Changes in global tropospheric OH expected as a result of climate change over the last several decades, *Journal of Geophysical Research: Atmospheres, 123*, 10,774–10,795, doi:10.1029/2018JD028388.

Prather, M. J., Flynn, C. M., Zhu, X., Steenrod, S. D., **Strode, S. A.**, Fiore, A. M., Correa, G., Murray, L. T., and Lamarque, J. (2018): How well can global chemistry models calculate the reactivity of short-lived greenhouse gases in the remote

troposphere, knowing the chemical composition. *Atmospheric Measurement Techniques, 11*(5), 2653-2668. doi:10.5194/amt-11-2653-2018.

Prather, M. J., X. Zhu, C. M. Flynn, **S. A. Strode**, J. M. Rodriguez, S. D. Steenrod, J. Liu, J.-F. Lamarque, A. M. Fiore, L. W. Horowitz, J. Mao, L. T. Murray, D. T. Shindell, and S. C. Wofsy (2017): Global atmospheric chemistry – which air matters, *Atmospheric Chemistry and Physics 17* (14): 9081-9102, doi:10.5194/acp-17-9081-2017.

Strode, S.A., A. R. Douglass, J. R. Ziemke, M Manyin, J. E. Nielsen and L. D. Oman (2017), A model and satellite-based analysis of the tropospheric ozone distribution in clear versus convectively cloudy conditions. *Journal of Geophysical Research: Atmospheres*, 122, doi:10.1002/2017JD27015.

Ziemke, J. R., **S. A. Strode**, A. R. Douglass, J. Joiner, A. Vasilkov, L. D. Oman, J. Liu, S. E. Strahan, P. K. Bhartia, and D. P. Haffner (2017) A cloud-ozone data product from Aura OMI and MLS satellite measurements, *Atmos. Meas. Tech., 1*0, 4067-4078, doi:10.5194/amt-10-4067-2017.

Elshorbany, Y. F., B. N. Duncan, **S. A. Strode**, J. S. Wang, and J. Kouatchou (2016), The description and validation of the computationally Efficient CH 4–CO–OH (ECCOHv1. 01) chemistry module for 3-D model applications, *Geoscientific Model Development*, *9*(2), 799-822 doi:10.5194/gmd-9-799-2016.

Flynn, C. M. et al (2016), Variability of O3 and NO2 profile shapes during DISCOVER-AQ: Implications for satellite observations and comparisons to model-simulated profiles, *Atmos. Environ., 147*, 133-156, doi:10.1016/j.atmosenv.2016.09.068.

Silva, R. A. et al (2016), The effect of future ambient air pollution on human premature mortality to 2100 using output from the ACCMIP model ensemble, *Atmos. Chem. Phys., 16*, 9847-9862, doi:10.5194/acp-16-9847-2016.

Strode, S.A., H. M. Worden, M. Damon, A. R. Douglass, B. N. Duncan, L. K. Emmons, J.-F. Lamarque, M. Manyin, L. D. Oman, J. M. Rodriguez, S. E. Strahan, and S. Tilmes (2016), Interpreting space-based trends in carbon monoxide with multiple models, *Atmos. Chem. Phys., 16*, 7285-7294, doi:10.5194/acp-16-7285-2016.

Emmons, L. K., et al. (2015), The POLARCAT Model Intercomparison Project (POLMIP): overview and evaluation with observations, *Atmospheric Chemistry and Physics*, *15*(12), 6721-6744, doi:10.5194/acp-15-6721-2015.

Schnell, J. L., et al. (2015), Use of North American and European air quality networks to evaluate global chemistry-climate modeling of surface ozone, *Atmospheric Chemistry and Physics*, *15*(18), 10581-10596, doi:10.5194/acp-15-10581-2015.

Strode, S., B. Duncan, E. Yegorova, J. Kouatchou, J. Ziemke, and A. Douglass (2015a), Implications of carbon monoxide bias for methane lifetime and atmospheric

composition in chemistry climate models, *Atmospheric Chemistry and Physics*, *15*(20), 11789-11805, doi:10.5194/acp-15-11789-2015.

Strode, S. A., J. M. Rodriguez, J. A. Logan, O. R. Cooper, J. C. Witte, L. N. Lamsal, M. Damon, B. Van Aartsen, S. D. Steenrod, and S. E. Strahan (2015b), Trends and variability in surface ozone over the United States, *Journal of Geophysical Research: Atmospheres*, *120*(17), 9020-9042, doi:10.1002/2014JD022784.

Chin, M., et al. (2014), Multi-decadal aerosol variations from 1980 to 2009: a perspective from observations and a global model, *Atmos. Chem. Phys., 14*, 3657-3690, doi:10.5194/acp-14-3657-2014.

Strode, S. A. and S. Pawson (2013), Detection of carbon monoxide trends in the presence of Interannual variability*, J. Geophys. Res. Atmos., 118,* 12,257–12,273*, doi:*10.1002/2013JD020258.

Bowman, K. W., et al. (2013), Evaluation of ACCMIP outgoing longwave radiation from tropospheric ozone using TES satellite observations. *Atmos*. *Chem*. *Phys*. 13(8), 4057-4072, doi:10.5194/acp-13-4057-2013.

Kirschke, S. et al. (2013), Three decades of global methane sources and sinks." *Nature Geosci*. 6(10), 813-823, doi:10.1038/ngeo1955.

Lamarque, J. F., et al. (2013), The Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP): overview and description of models, simulations and climate diagnostics. *Geosci*. *Model Devel*. 6(1), 179-206, doi:10.5194/gmd-6-179-2013.

Lamarque, J.-F. et al. (2013), Multi-model mean nitrogen and sulfur deposition from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP): evaluation of historical and projected future changes, *Atmos. Chem. Phys., 13*, 7997-8018, doi:10.5194/acp-13-7997-2013

Naik et al. (2013), Preindustrial to present-day changes in tropospheric hydroxyl radical and methane lifetime from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), *Atmos. Chem. Phys., 13*, doi:10.5194/acp-13-5277-2013.

Silva, R.A., et al. (2013), Global premature mortality due to anthropogenic outdoor air pollution and the contribution of past climate change. *Environ. Res. Lett.* 8(3), 034005, doi:10.1088/1748-9326/8/3/034005.

Stevenson, D. S., et al. (2013), Tropospheric ozone changes, radiative forcing and attribution to emissions in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). *Atmos. Chem. Phys.* 13(6) , 3063-3085, doi:10.5194/acp-13-3063-2013.

Vougarakis et al. (2013), Analysis of present day and future OH and methane lifetime in the ACCMIP simulations, *Atmos. Chem. Phys., 13*, doi:10.5194/acp-13-2563-2013.

Young, P. J., et al. (2013), Pre-industrial to end 21st century projections of tropospheric ozone from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). *Atmos. Chem. Phys.* 13(4), 2063-2090, doi:10.5194/acp-13-2063-2013.

Strode, S. A., L. E. Ott, S. Pawson, and T. W. Bowyer (2012), Emission and transport of cesium-137 from boreal biomass burning in the summer of 2010, *J. Geophys. Res., 117*, D09302, 2011JD017382, doi: 10.1029/2011JD017382.

Soerensen, A.L., E.M. Sunderland, C.D. Holmes, D.J. Jacob, R. M. Yantosca, H. Skov, J.H. Christensen, **S.A. Strode**, and R.P. Mason (2010), An improved global model for air-sea exchange of mercury: High concentrations over the North Atlantic, *Environ. Sci. Technol.* 44(22), 8574-8580x, doi:10.1021/es102032g.

Strode, S., L. Jaeglé, and S. Emerson (2010), Vertical transport of anthropogenic mercury in the ocean, *Global Biogeochem. Cycles, 24,* GB4014, doi:*10.1029/2009GB003728*.

Sinha, P., W.A. Schew, A. Sawant, K.J. Kolwaite, and **S. Strode** (2010), Greenhouse gas emissions from U.S. institutions of higher education, J. Air & Waste Manage. Assoc., 60(5), 568-573, doi:10.3155/1047-3289.60.5.568.

Strode, S., L. Jaeglé, and N. E. Selin (2009), Impact of mercury emissions from historic gold and silver mining: Global modeling, Atmos. Environ.,*43*, 2012-2017, doi:10.1016/j.atmosenv.2009.01.006.

Reidmiller, D.R., D. A. Jaffe, D. Chand, **S. Strode**, P. C. Swartzendruber, G. M. Wolfe, and J. A. Thornton (2009), Interannual variability of long-range transport as seen at the Mt. Bachelor Observatory, Atmos. Chem. Phys., *9*, 557-572.

Jaeglé, L., **S. Strode**, N. Selin, and D. Jacob (2009), The GEOS-Chem Model, in Mercury Fate and Transport in the Global Atmosphere, p. 720, Springer-Verlag, Berlin.

Sunderland, E.M., D.P. Krabbenhoft, J.M. Moreau, **S.A. Strode**, and W.M. Landing (2009), Mercury sources, distribution and bioavailability in the North Pacific Ocean: Insights from data and models. Global Biogeochem. Cycles, 23, GB2010, doi:10.1029/2008GB003425.

Strode, S.A., L. Jaeglé, D.A. Jaffe, P.C. Swartzendruber , N.E. Selin, C. Holmes, and R.M. Yantosca, Trans-Pacific transport of mercury (2008), J. Geophys. Res., 113(D15305), doi:10.1029/2007JD009428.

Jaffe, D. and **S. Strode** (2008), Fate and Transport of Atmospheric Mercury from Asia, Environ. Chem., 5, 121, doi:10.1071/EN08010.

Selin, N.E., D.J. Jacob, R.M. Yantosca, **S. Strode**, L. Jaeglé, and E.M. Sunderland (2008), Global 3-D land-ocean-atmosphere model for mercury: present-day vs. pre-industrial cycles and anthropogenic enrichment factors for deposition, Global Biogeochemical Cycles, 22(GB2011), doi:10.1029/2007GB003040.

Swartzendruber, P. C., D. Chand, D. A. Jaffe, J. Smith, D. Reidmiller, L. Gratz, J. Keeler, **S. Strode**, L. Jaeglé, and R. Talbot (2008), Vertical distribution of mercury, CO, ozone, and aerosol scattering coefficient in the Pacific Northwest during the spring 2006 INTEX-B campaign, J. Geophys. Res., 113, D10305, doi:10.1029/2007JD009579.

Strode, S., L. Jaeglé, N. Selin, D. J. Jacob, R. Park, R. Yantosca, R. P. Mason, and F. Slemr (2007), Air-sea exchange in the global mercury cycle, Global Biogeochemical Cycles, 21(GB1017), doi:10.1029/2006GB002766.

Selin, N., D. J. Jacob, R. Park, R. Yantosca, **S. Strode**, L. Jaeglé, and D. Jaffe (2007), Chemical cycling and deposition of atmospheric mercury: Global constraints from observations, J. Geophys. Res., 112(D02308), doi:10.1029/2006JD007450.

Swartzendruber, P.C., D.A. Jaffe, E.M. Prestbo, P. Weiss-Penzias, N.E. Selin, R. Park, D. Jacob, **S. Strode**, and L. Jaeglé (2006), Observations of reactive gaseous mercury in the free-troposphere at the Mt. Bachelor observatory, J. Geophys. Res., 11(D24301), doi:10.1029/2006JD007415.

PROFESSIONAL INVOLVEMENT:

Member, U. Washington Atmos. Sci. Faculty Search Student Committee (2006)
Member, Program on Climate Change Outreach Committee (2006-2008)
Member, American Geophysical Union
Member, American Meteorological Society
Member, TOAR II focus group on tropospheric ozone precursors
Reviewer for Nature Communications, JGR, Geophysical Research Letters, ACP, Atmospheric Environment, Environmental Science and Technology, and Environmental Pollution