

## Stephen A. Montzka

### **I. Education:**

Ph.D. 1988 Analytical Chemistry, University of Colorado, Boulder.  
B.S. 1983 Summa Cum Laude with Highest Honors in Chemistry, St. Lawrence University.

### **II. Employment:**

12/21 – NOAA/GML Senior Scientist.  
1/21-12/21 Chief, Halocarbon and Trace Species Division of NOAA’s Global Monitoring Laboratory. The Division maintains multiple sampling networks and measurements systems to track global atmospheric abundances of 40+ chemicals affecting climate, stratospheric ozone, and air quality. The Division also participates in process-based studies providing an improved understanding of atmospheric chemistry and dynamics. The data the Division supplies are integral to NOAA’s Annual Greenhouse Gas Index and the Ozone-Depleting Gas Index, which are internationally recognized metrics of the atmospheric abundance of climate-active and ozone-depleting gases; they also are regularly highlighted in international scientific assessments related to ozone depletion and climate commissioned by the World Meteorological Organization and the Intergovernmental Panel on Climate Change.  
3/91-12/20 Research Chemist, NOAA’s Global Monitoring Laboratory. Dr. Montzka led the Chlorofluorocarbons Alternative Monitoring Project responsible for ongoing global atmospheric measurements of over 30 chemicals at multiple remote sites across the globe that influence climate, stratospheric ozone, and air quality.  
1/89-3/91 National Research Council Post-Doctoral Fellow, Aeronomy Laboratory (now Chemical Sciences Division), NOAA.

### **III. Awards and Honors**

2020 U.S. Department of Commerce Gold Medal  
2019 NOAA/OAR Dr. Daniel L. Albritton Outstanding Science Communicator Award  
2019, 2020, 2021 Web of Science Highly Cited Researcher, Geosciences  
2019 Colorado Governor’s Award for High-Impact Research  
2019 NASA Group Achievement Award, ATom mission  
2018 Named a Fellow of the American Geophysical Union  
2016 Elected a member of the International Ozone Commission  
2016 Excellence in Refereeing Editor’s Citation by GRL  
2015 Nominated into the Montreal Protocol’s Who’s Who  
2014 Colorado Governor’s Award for High-Impact Research  
2012 Excellence in Refereeing Editor’s Citation by JGR-A

2011	Elected a Fellow of CIRES, Univ. of Colorado
2008	U.S. Department of Commerce Silver Medal
2008	NOAA Administrator Award
2007	Excellence in Refereeing Editor's Citation by GRL
2007	U.S. EPA Stratospheric Ozone Protection Award
2000	NOAA Research Employee of the Year
1997	U.S. Department of Commerce Silver Medal
1995, 1996, 1998, 1999(x3), 2003, 2007, 2011	Recipient of the NOAA Outstanding Scientific Paper of the Year Award ( <i>nine times</i> ).
1994, 1995, 2003	NASA Group Achievement Awards for separate field missions.
1992, 1993, 1997	U.S. Department of Commerce, NOAA Certificate of Recognition.
1989, 1990	National Research Council Post-Doctorate Fellowships
1983, 1984	Colorado Doctoral Fellowships
1982	Phi Beta Kappa

#### **IV. Participation in National and International Scientific Assessment Reports:**

##### **1. WMO/UNEP Scientific Assessment Panel's reports on Ozone Depletion:**

- Lead author (with S. Park) of Section 3, *Emissions*, for the "Report on the unexpected emissions of CFC-11", 2021.
- For the 2022 Quadrennial Report:
  - Review Editor, Chapter 2
- For the 2018 Quadrennial Report:
  - Coordinating Lead Author of Chapter 2 (with G. Velders)
  - Contributor, Chapter 1 and Chapter 6
- For the 2014 Quadrennial Report:
  - Review Editor, Chapter 1;
  - Co-author of the "Twenty questions and answers about the ozone layer: 2014 update.
- For the 2010 Quadrennial Report:
  - Coordinating Lead Author of Chapter 1 (with S. Reimann)
  - Co-Author, Chapter 5
- For the 2006 Quadrennial Report:
  - Co-Author, Chapter 1
  - Contributor, Chapter 8
  - Liaison for Chapters 1 and 2, and for Chapters 1 and 8.
- For the 2002 Quadrennial Report:
  - Lead Author (with P. Fraser), Chapter 1
- For the 1998 Quadrennial Report:
  - Co-Author, Chapter 2
  - Contributor, Chapter 1

##### **2. IPCC Working Group 1 Climate Change Reports:**

- Third Assessment Report (2001), *Climate Change 2001, The Scientific Basis*,

Contributing Author, Chapter 4  
Fourth Assessment Report (2007), *Climate Change 2007, The Physical Science Basis*, Contributing Author, Chapter 2  
Fifth Assessment Report (2013), *Climate Change 2013, The Physical Science Basis*, Contributing Author, Chapter 2 (and reviewer)  
Sixth Assessment Report (2021), co-lead of the US Government Review of Chapter 2, Emissions in Working Group III.

**3. WMO/WCRP SPARC Reports:**

- a. Assessment of Stratospheric Aerosol Properties (2006): Author, Chapter 2
- b. Lifetimes of Stratospheric Ozone-Depleting Substances, Their Replacements, and Related Species: Co-Author, Chapter 4 (December 2013)
- c. The Mystery of Carbon Tetrachloride: Author (July 2016)

**4. Climate Change Science Plan Synthesis and Assessment Product 2.4 (2008):**  
Convening Lead Author, Chapter 2

**5. TEAP/UNEP Task Force on Emissions Discrepancies Report (2006):**  
Lead Author and co-Chair

**6. IPCC/TEAP Special Report on Safeguarding the Ozone Layer and the Global Climate System (2005):** Contributing Author, Chapter 1 and Chapter 2 (and expert reviewer)

**7. UNEP Synthesis Report “HFCs, A critical link in protecting climate and the ozone layer”,** contributor, 2011.

**8. IPCC Emissions Gap Report 2012:** Contributing Author, Chapter 1

**9. Consulting expert to the Montreal Protocol’s Technology and Economic Assessment Panel’s report on CFC-11:** “Volume 3: Decision XXXI-3 TEAP Task Force Report on Unexpected Emissions of Trichlorofluoromethane (CFC-11), 2021.

**V. Peer-Reviewed Publications (published or in press as of December, 2021):**  
**H-index = 65 (Web of Science):**

1. Adcock, K.E. P.J. Fraser, B.D. Hall, R.L. Langenfelds, G. Lee, S.A. Montzka, D.E. Oram, T. Rockmann, F. Stroh, W.T. Sturges, B. Vogel, J.C. Laube, Aircraft-based observations of ozone-depleting substances in the upper troposphere and lower stratosphere in and above the Asian summer monsoon, *J. Geophys. Res.: Atmos*, 126, e2020JD033137. <https://doi.org/10.1029/2020JD033137>, 2021.
2. Angot, H., C. Davel, C. Wiedinmyer, G. Pétron, J. Chopra, J. Hueber, B. Blanchard, I. Bourgeois, H. Bourgeois, I. Vimont, S.A. Montzka, B.R. Miller, J.W. Elkins, D. Helmig, Temporary pause in the growth of atmospheric ethane and propane in 2015-2018, *Atmos. Chem. Phys.*, 21, 15153-15170, 2021.  
<https://doi.org/10.5194/acp-21-15153-2021>
3. Bruhwiler, L.M., S. Basu, J.H. Butler, A. Chatterjee, E. Dlugokencky, M.A. Kenny, A. McComiskey, S.A. Montzka, D. Stanitski, Observations of greenhouse gases as climate indicators, *Climatic Change*, 165, 12, 2021.  
<https://doi.org/10.1007/s10584-021-03001-7>.

4. Gonzalez, Y. et al., Impact of stratospheric air and surface emissions on tropospheric nitrous oxide during ATom, *Atmos. Chem. Phys.*, *21*, 11113–11132, 2021. <https://doi.org/10.5194/acp-21-11113-2021>.
5. Hintsä, E.J. et al., UAS chromatograph for atmospheric trace species (UCATS) – a versatile instrument for trace gas measurements on airborne platforms, *Atmos. Meas. Tech.*, *14*, 6795–6819, 2021. <https://doi.org/10.5194/amt-14-6795-2021>.
6. Hu, L., S.A. Montzka, A. Kaushik, A. Andrews, C. Sweeney, J. Miller, I.T. Baker, S. Denning, E. Campbell, Y.P. Shiga, P. Tans, M.C. Siso, M. Crowell, K. McKain, K. Thoning, B. Hall, I. Vimont, J.W. Elkins, M.E. Whelan, P. Suntharalingam, COS-derived GPP relationships with temperature and light help explain high-latitude atmospheric CO<sub>2</sub> seasonal cycle amplification, *Proc. Nat. Acad. Sci.*, *118*, 33, 2021. <https://doi.org/10.1073/pnas.2103423118>.
7. Ma, J., L.M.J. Kooijmans, A. Cho, S.A. Montzka, M. Glatthor, J.R. Worden, L. Kuai, E.L. Atlas, M.C. Krol, Inverse modelling of carbonyl sulfide: implementation, evaluations and implications for the global budget, *Atmos. Chem. Phys.*, *21*, 3507–3529, 2021. <https://doi.org/10.5194/acp-21-3507-2021>.
8. Maignan, F., C. Abadie, M. Remaud, L.M.J. Kooijmans, K.-M. Kohonen, R. Commane, R. Wehr, J.E. Campbell, S. Belviso, S.A. Montzka, N. Raoult, U. Seibt, Y.P. Shiga, N. Vuichard, M.R. Whelan, P. Peylin, Carbonyl sulfide: Comparing a mechanistic representation of the vegetation uptake in a land surface model and the leaf relative uptake approach, *Biogeosci.*, *18*, 2917–2955, 2021. <https://doi.org/10.5194/bg-18-2917-2021>.
9. Montzka, S.A., G.S. Dutton, R.W. Portmann, M.P. Chipperfield, S. Davis, W. Feng, A.J. Manning, E. Ray, M. Rigby, B.D. Hall, C. Siso, J.D. Nance, P.B. Krummel, J. Muhle, D. Young, S. O’Doherty, P.K. Salameh, C. Harth, R.G. Prinn, R.F. Weiss, J.W. Elkins, H. Walter-Terrinoni, C. Theodoridi, A sharp decline in global CFC-11 emissions during 2018–2019, *Nature*, *590*, 428–432. <https://doi.org/10.1038/s41586-021-03260-5>, 2021.
10. Naus, S., S.A. Montzka, P.K. Patra, and M.C. Krol, A 3-D model inversion of methyl chloroform to constrain the atmospheric oxidative capacity, *J. Atmos. Chem. Phys.*, in press, 2021. <https://doi.org/10.5194/acp-2020-624>.
11. Nicewonger, M.R., E.S. Saltzman, S.A. Montzka, ENSO-driven fires cause large interannual variability in the naturally emitted, ozone-depleting trace gas methyl bromide, **in press**, 2021.
12. Oltmans, S.J., L. Cheadle, D. Helmig, H. Angot, G. Petron, S.A. Montzka, E.J. Dlugokencky, B. Miller, B. Hall, R.C. Schnell, J. Kofler, S. Wolter, M. Crowell, C. Siso, P. Tans, A. Andrews, Atmospheric oil and natural gas hydrocarbon trends in the Northern Colorado Front Range are notably smaller than inventory emission reductions, *Elem. Sci. Anth.*, *9*, 1. <https://doi.org/10.1525/elementa.2020.00136> 2021.
13. Orbe C., D.W. Waugh, S. Montzka, E.J. Dlugokencky, S. Strahan, S.D. Steenrod, S. Strode, J.W. Elkins, B. Hall, C. Sweeney, E.J. Hintsä, F.L. Moore, E. Penafiel, Tropospheric age-of-air: Influence of SF<sub>6</sub> emissions on recent surface trends and model biases, *J. Geophys. Res.*, *126*, e2021JD035451, 2021. <https://doi.org/10.1029/2021JD035451>.

14. Patra, P.K., M.C. Krol, R.G. Prinn, M. Takigawa, J. Mühle, S.A. Montzka, S. Lal, Y. Yamashita, S. Naus, N. Chandra, R.F. Weiss, P.B. Krummel, P.J. Fraser, S. O'Doherty, J.W. Elkins, Methyl chloroform continues to constrain the hydroxyl (OH) variability in the troposphere, *J. Geophys. Res.: Atmos.*, *126*, e2020JD033862. <https://doi.org/10.1029/2020JD033862>, 2021.
15. Park, S., L.M. Western, T. Saito, A.L. Redington, S. Henne, X. Fang, R.G. Prinn, A.J. Manning, S.A. Montzka, P.J. Fraser, A.L. Ganesan, C.M. Harth, J. Kim, P.B. Krummel, Q. Liang, J. Mühle, S. O'Doherty, H. Park, M.K. Park, S. Reimann, P.K. Salameh, R.F. Weiss, M. Rigby, A decline in emissions of CFC-11 and related chemicals from eastern China, *Nature*, *590*, 433-437. <https://doi.org/10.1038/s41586-021-03277-w>, 2021.
16. Thompson et al., The NASA atmospheric tomography (ATom) mission, imaging the chemistry of the global atmosphere, **in press**, 2021.
17. Villalba, G., M. Whelan, S.A. Montzka, P.J. Cameron-Smith, M. Fischer, A. Zumkehr, T. Hilton, J. Stinecipher, I. Baker, R.P. Bambha, H.A. Michelson, B.W. LaFranchi, C. Estruch, E. Campbell, Exploring the potential of using carbonyl sulfide to track the urban biosphere signal *J. Geophys. Res.*, *126*, e2020JD034106, 2021. <https://doi.org/10.1029/2020JD034106>
18. Aydin, M., G.L. Britten, S.A. Montzka, C. Buizert, F. Primeau, V. Petrenko, M.B. Battle, M.R. Nicewonger, J. Patterson, B. Hmiel, E.S. Saltzman, Anthropogenic impacts on atmospheric carbonyl sulfide since the 19th century inferred from polar firn air and ice core measurements. *J. Geophys. Res.*, *125*, e2020JD033074. <https://doi.org/10.1029/2020JD033074>, 2020.
19. Baier, B., C. Sweeney, Y. Choi, K.J. Davis, J.P. DiGangi, S. Feng, A. Fried, H. Holiday, J. Higgs, T. Lauvaux, B.J. Miller, S.A. Montzka, T. Newberger, J.B. Nowak, P. Patra, D. Richter, J. Walega, and P. Welbring, Multispecies assessment of factors influencing regional CO<sub>2</sub> and CH<sub>4</sub> enhancements during the winter 2017 ACT-America campaign, *J. Geophys. Res.: Atmos.*, *125*, e2019JD031330, doi:10.1029/2019JD031339, 2020.
20. Chipperfield, M.P., R. Hossaini, S.A. Montzka, S. Reimann, D. Sherry, S. Tegtmeier, Renewed and emerging concerns over production and emissions of ozone-depleting substances, *Nat. Rev., Earth Environ.*, <https://doi.org/10.1038/s43017-020-0048-8>, 2020.
21. Claxton, T., R. Hossaini, C. Wilson, S.A. Montzka, M.P. Chipperfield, O. Wild, E. Bednarz, L. Carpenter, S. Andrews, S. Hackenberg, J. Mühle, D. Oram, S. Park, M.-K. Park, E. Atlas, M. Navarro, S. Schaufli, D. Sherry, M. Vollmer, T. Schuck, A. Engel, M. Maione, J. Arduini, T. Saito, Y. Yokouchi, S. O'Doherty, D. Young, C. Lunder, A synthesis inversion to constrain global emissions of very short-lived chlorocarbons, dichloromethane and perchloroethylene, *J. Geophys. Res.*, *125*, e2019JD03181. <https://doi.org/10.1029/2019JD0318182020>, 2020.
22. Hall, B.D., G. Dutton, S.A. Montzka, B.R. Miller and J.W. Elkins, (2020), Atmospheric Composition, Ozone-depleting substances [in "State of the Climate 2019"], *Bulletin of the American Meteorological Society*, *101*, 8, S75-S76, 10.1175/BAMS-D-20-0104.1.
23. Laube, J.C., E.C. Leedham Elvidge, K.E. Adcock, B. Baier, C.A.M. Brenninkmeijer, H. Chen, E.S. Droste, J.-U. Grooß, P. Heikkinen, A.J. Hind, R. Kivi, A. Lojko, S.A.

- Montzka, D.E. Oram, S. Randall, T. Rockmann, W.T. Sturges, C. Sweeney, A. Thomas, E. Tuffnell, F. Ploeger, Investigating stratospheric changes between 2009 and 2018 with halogenated trace gas data from aircraft, AirCores, and a global model focusing on CFC-11, *Atmos. Chem. Phys.*, 20, 9771-9782, <https://doi.org/10.5194/acp-20-9771-2020>, 2020.
24. Lickley, M., S. Solomon, S. Fletcher, G.J.M. Velders, J. Daniel, M. Rigby, S.A. Montzka, L.J.M. Kuijpers, K. Stone, Quantifying contributions of chlorofluorocarbon banks to emissions and impacts on the ozone layer and climate, *Nat. Communications*, 11:1380, <https://doi.org/10.1038/s41467-020-15162-7>, 2020.
25. Meinshausen, M., Z.R.J. Nicholls, J. Lewis, M.J. Gidden, E. Vogel, M. Freund, U. Beyerle, C. Gessner, A. Nauels, N. Bauer., J.G. Canadell, J.S. Daniel, A. John, P.B. Krummel, G. Luderer, N. Meinshausen, S.A. Montzka, P.J. Rayner, S. Reimann, S.J. Smith, M. van den Berg, G.J.M. Velders, M.K. Vollmer, H.J. (Ray) Wang, The shared socio-economic pathway (SSP) greenhouse gas concentrations and their extensions to 2500, *Geosci. Model Dev.*, 13, 3571-3605, <https://doi.org/10.5194/gmd-13-3571-2020>, 2020.
26. Ray, E., R.W. Portmann, P. Yu, J. Daniel, S.A. Montzka, G.S. Dutton, B.D. Hall, F.L. Moore, K.H. Rosenlof, The influence of the stratospheric Quasi-Biennial Oscillation on trace gas levels at the Earth's Surface, *Nat. Geosci.*, [doi.org/10.1038/s41561-019-0507-3](https://doi.org/10.1038/s41561-019-0507-3), 2020.
27. Dhomse, S.S., W. Feng, S.A. Montzka, R. Hossaini, J. Keeble, J.A. Pyle, J.S. Daniel, and M.P. Chipperfield, Delay in recovery of the Antarctic ozone hole from unexpected CFC-11 emissions, *Nature Comms.*, [doi:10.1038/s41467-019-13717-x](https://doi.org/10.1038/s41467-019-13717-x), 2019.
28. Hossaini, R. E. Atlas, S.S. Dhomse, M.P. Chipperfield, P.F. Bernath, A.M. Fernando, J. Mühle, A.A. Leeson, S.A. Montzka, W. Feng, J.J. Harrison, P. Krummel, M.K. Vollmer, S. Reimann, S. O'Doherty, D. Young, M. Maione, J. Arduini, C.R. Lunder, Recent trends in stratospheric chlorine from very short-lived substances, *J. Geophys. Res.*, 124, 4, 2318-2335, [doi.org/10.1029/2018JD029400](https://doi.org/10.1029/2018JD029400), 2019.
29. Hu, L., A.E. Andrews, K.W. Thoning, C. Sweeney, J.B. Miller, A. Michalak, E. Dlugokencky, P.P. Tanks, Y.P. Shiga, M. Mountain, T. Nehrkorn, S.A. Montzka, K. McKain, J. Kofler, M. Trudeau, S.E. Michel, S.C. Biraud, M.L. Fischer, D.E.J. Worthy, B.H. Vaughn, J.W.C. White, V. Yadav, S. Basu, I.R. van der Velde, Enhanced North American carbon uptake associated with El Nino, *Sci. Adv.*, 5, [doi:10.1126/sciadv.aaw0076](https://doi.org/10.1126/sciadv.aaw0076), 2019.
30. Li, P., J. Mühle, S.A. Montzka, D.E. Oram, B.R. Miller, T. Tanhua, Atmospheric histories, growth rates and solubilities in seawater and other natural waters of the potential transient tracers HCFC-22, HCFC-141b, HCFC-142b, HFC-134a, HFC-125, HFC-23, PFC-14 and PFC-116, *Ocean Sci.*, 15, 33-60, [doi.org/10.5194/os-15-33-2019](https://doi.org/10.5194/os-15-33-2019), 2019.
31. Lan, X., P. Tans, C. Sweeney, A. Andrews, E. Dlugokencky, S. Schwietzke, J. Koffler, K. McKain, K. Thoning, M. Crotwell, S. Montzka, B.J. Miller, S.C. Biraud, Long-term measurements show little evidence for large increases in total U.S. methane emissions over the past decade, *Geophys. Res. Lett.*, 46, 4991-4999, [doi:10.1029/2018GL081731](https://doi.org/10.1029/2018GL081731), 2019.

32. Naus, S., S.A. Montzka, S. Pandey, S. Basu, E.J. Dlugokencky, M. Krol, Constraints and biases in a tropospheric two-box model of OH, *Atmos., Chem. Phys.*, 19, 407-424, doi.org/10.5194/acp-19-407-2019, 2019.
33. Rigby, M., S. Park, T. Saito, L.M. Western, A.L. Redington, X. Fang, S. Henne, A.J. Manning, R.G. Prinn, G.S. Dutton, P.J. Fraser, A.L. Ganesan, B.D. Hall, C.M. Harth, J. Kim, K.-R. Kim, P.B. Krummel, T. Lee, S. Li, Q. Liang, M.F. Lunt, S.A. Montzka, J. Mühle, S. O'Doherty, M.-K. Park, S. Reimann, P.K. Salameh, P. Simmonds, R.L. Tunnicliffe, R.F. Weiss, Y. Yokouchi, D. Young, Increase in CFC-11 emissions from eastern China based on atmospheric observations, *Nature*, 569, 546-550, doi.org/10.1038/s41586-019-1193-4, 2019.
34. Wang, S., Kinnison, D., S.A. Montzka, E.C. Apel, R.S. Hornbrook, A.J. Hills, D.R. Blake, B. Barletta, S. Meinardi, C. Sweeney, F. Moore, M. Long, A. Saiz-Lopez, R.P. Fernandez, S. Tilmes, L.K. Emmons, J.-F. Lamarque, Ocean Biogeochemistry Control on the Marine Emissions of Brominated Very Short-Lived Ozone-Depleting Substances: a Machine-Learning Approach, doi:10.1029/2019JD031288, 2019.
35. Brunner, D., A. Manning, R. Weiss, M. Maione, J. Sussams, S. Henne, S. Reiman, S. Montzka, Top-down estimates of halocarbon emissions, Chapter 6 in the IMWS report, JRC "Science for Policy reports", EU, 2018.
36. Butler, R., P.I. Palmer, L. Feng, S.J. Andrews, E.L. Atlas, L.J. Carpenter, V. Donets, N.R.P. Harris, S.A. Montzka, L.L. Pan, R.J. Salawitch, S.M. Schauffler, Quantifying the vertical transport of CHBr<sub>3</sub> and CH<sub>2</sub>Br<sub>2</sub> over the western Pacific, *Atmos. Chem. Phys.*, 18, 13135-13153, doi:10.5194/acp-2018-18-13135-2018.
37. Li, S., S. Park, J.-Y. Lee, K.-J. Ha, M.-K. Park, C.O. Jo, H. Oh, J. Mühle, K.-R. Kim, S.A. Montzka, S. O'Doherty, P.B. Krummel, E. Atlas, B.R. Miller, F. Moore, R. Weiss, S.C. Wofsy, Chemical evidence of inter-hemispheric air mass intrusion into the Northern Hemisphere mid-latitudes, *Scientific Reports*, 8:4669, doi: 10.1038/s41598-018-22266-0, 2018.
38. Montzka, S.A., G.S. Dutton, P. Yu, E. Ray, R.W. Portmann, J.S. Daniel, L. Kuijpers, B.D. Hall, D. Mondeel, C. Siso, D.J. Nance, M. Rigby, A.J. Manning, L. Hu, F. Moore, B.R. Miller, J.W. Elkins, A persistent and unexpected increase in global emissions of ozone-depleting CFC-11, *Nature*, 557, 413-417, https://doi.org/10.1038/s41586-018-0106-2, 2018.
39. Montzka, S.A., G.J.M. Velders (lead authors), P.B. Krummel, J. Mühle, V.L. Orkin, S. Park, H. Walters-Terronini, N. Shah, Hydrofluorocarbons (HFCs), Chapter 2 in Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project—Report No. 58, World Meteorological Organization, Geneva, Switzerland, 2018.
40. Reimann, S., J.W. Elkins, P.J. Fraser, B.D. Hall, M.J. Kurylo, E. Mahieu, S.A. Montzka, R.G. Prinn, M. Rigby, P.G. Simmonds, R.F. Weiss, Observing the atmospheric evolution of ozone-depleting substances, *C. R. Geoscience.*, 350, 384-392, https://doi.org/10.1016/j.crte.2018.08.008, 2018.
41. Whelan, M.E., S.T. Lennartz, T.E. Gimeno, R. Wehr, G. Wohlfahrt, Y. Wang, L.M. J. Kooijmans, T.W. Hilton, S. Belviso, P. Peylin, R. Commane, W. Sun, H. Chen, L. Kuai, I. Mammarella, K. Maseyk, M. Berkelhammer, K.-F. Li, D. Yakir, A. Zumkehr, Y. Katayama, J. Ogée, F.M. Spielmann, F. Kitz, B. Rastogi, J. Kesselmeier, J.

- Marshall, K.-M. Erkkilä, L. Wingate, L.K. Meredith, W. He, R. Bunk, T. Launois, T. Vesala, J.A. Schmidt, C.G. Fichot, U. Seibt, S. Saleska, E.S. Saltzman, S.A. Montzka, J. A. Berry, and J.E. Campbell, Reviews and Syntheses: Carbonyl Sulfide as a Multi-scale Tracer for Carbon and Water Cycles, *Biogeosciences*, 15, 3625-3657, <https://doi.org/10/5194/bd-15-3625-2018>.
42. Bruhwiler, L.M., S. Basu, P. Bergamaschi, P. Bousquet, E. Dlugokenchy, S. Houweling, M. Ishizawa, H.-S. Kim, R. Locatelli, S. Maksyutov, S. Montzka, S. Pandey, P.K. Patra, G. Petron, M. Saunois, C. Sweeney, S. Schwietzke, P. Tans, E.C. Weatherhead, U.S. CH<sub>4</sub> emissions from oil and gas production: Have recent large increases been detected? *J. Geophys. Res.*, 122, 4070-4083, doi:10.1002/2016JD026157, 2017.
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## **VI. Special Projects/Field Missions:**

1. Project leader, the Chlorofluorocarbons Alternatives Measurement Project—flask analysis by GCMS (1991-present). (NOAA)
2. Co-Principle Investigator with L. Hu, on “Estimating U.S. emissions of non-CO<sub>2</sub> greenhouse gases using long-term atmospheric observations,” 2019-2021. (GIST.earth, LLC)
3. Co-Principle Investigator with L. Hu, on “More precisely locating sources of the unexpected increase in CFC-11 emissions using HIPPO and ATom data,” 2019-2021. (NASA)
4. Co-Principle Investigator with C. Sweeney, for flask sampling during the NASA-funded Atmospheric Tomography Experiment (ATom), 2016-2018. (NASA)

5. Co-Investigator with J. Elkins and F. Moore on the NSF-funded High Performance Instrumented Airborne Platform for Environmental Research (HIAPER) Pole-to-Pole Observations of Greenhouse Gases (HIPPO 1 to 5) mission, 2008-2012. (NSF)
6. Co-Investigator with S. Lehman and J. Miller on “Quantifying regional emissions ratios using  $^{14}\text{CO}_2$ ” (NOAA; 2012-2015). (NOAA)
7. Flask sampling on the NOAA-P3 as part of the NOAA Aerosol, Radiation, and Cloud Processes affecting Arctic Climate mission, Spring 2008.
8. Co-PI, with P. Tans and D. Yakir on a U.S.-Israel Bi-national Science Foundation Grant, 2005-2008.
9. GCMS flask measurements for Trans-Siberian Railway Observations into the Chemistry of the Atmosphere, TROICA-8, Russia, March-April 2004.
10. Instrument assistance onboard NASA’s DC-8 during the SAGE II Ozone Loss and Validation Experiment, Kiruna, Sweden, January 2003.
11. Surface firn air sampling and firn-air sampling tube installation, South Pole, January 2001.
12. Instrument installation onboard NOAA’s R.H. Brown in preparation of the Gas Exchange Experiment, Miami, May 1998.
13. Instrument assistance during NASA’s Observations of the Middle Stratosphere Balloon mission, Ft. Sumner, New Mexico, September 14-19, 1996.
14. Airborne Southern Hemisphere Ozone Experiment / Measurements for Assessing the Effects of Stratospheric Aircraft, Christchurch, New Zealand, September-October 1994.
15. Bromine Latitude Air-Sea Transect, onboard the NOAA Discoverer, January 1994.
16. Stratospheric Photochemistry and Dynamics Experiment, San Jose, May 1993.
17. Rural Oxidants in the Southern Environment II, Alabama, June-July 1992.
18. Rural Oxidants in the Southern Environment I, Alabama, June-July 1990.
19. Flasks have been analyzed as part of multiple firn-air sampling in Antarctica (South Pole-2000, -2008, -2015; Siple Dome-1996; Megadunes-2004; and WAIS-2005) and in Greenland (Tunu-1996, Summit-2004 through 2008, Rennland-2015).

## **VII. Invited Presentations:**

1. “A rapid turnaround in the global emission increase observed recently for CFC-11”, presented to the Montreal Protocol’s Technology and Economic Assessment Panel, March 2021.
2. “Guiding ozone layer recover with effective science and policy on an international scale”, presented as part of the CU/CIRES Center for Science and Technology Policy Research Spring seminar series, Boulder, March 2020.
3. “On science informing international policy: Are emissions of a banned ozone-depleting substance really increasing?” Invited colloquium speaker at the University of Toronto Department of Physics, 27 February, 2020.



4. "On science informing international policy: Are emissions of a banned ozone-depleting substance really increasing?" Invited talk presented at the NCAR ACOM seminar series, 26 August, 2019.
5. "New insights into the source of increased CFC-11 emissions", presented as a side event at the 41<sup>st</sup> Open-Ended Working Group of the Montreal Protocol on Substances that Deplete the Ozone Layer, July 2019, Bangkok, Thailand.
6. "Atmospheric measurements of CFC-11 through 2018: Are global CFC-11 emissions back on the decline?" Invited talk presented at the International Symposium on the unexpected increase in emissions of ozone-depleting CFC-11, 25-27 March, 2019.
7. "On science informing international policy: Are emissions of a banned ozone-depleting substance really increasing?" Invited talk presented at the University of Vienna seminar series, 22 March, 2019.
8. "A scientific understanding of recent atmospheric observations of CFC-11", invited talk presented at the International workshop on capacity building for the implementation of the Montreal Protocol in China, 18 March 2019, Beijing, China.
9. "Towards a further understanding of the magnitude and underlying cause for the recent increase in global CFC-11 emission", invited talk at the 2018 Fall AGU meeting, Washington, D.C., December 12, 2018.
10. "Atmospheric Science insights from long-term global-scale air sampling", invited talk at the New Fellows in Atmospheric Sciences Session at the 2018 Fall AGU meeting, Washington, D.C., December 12, 2018.
11. "Updates to our understanding of the recent increase in CFC-11 emissions", presented as a side event at the 30<sup>th</sup> Meeting of the Parties of the Montreal Protocol on Substances that deplete the Ozone Layer, November 2018, Quito, Ecuador.
12. "The evidence for increasing emissions of CFC-11", presented as a side event at the Open-Ended Working Group of the Montreal Protocol on Substances that deplete the Ozone Layer, July 2018, Vienna, Austria.
13. "Methyl Bromide in the Atmosphere—A Scientific Overview and Update", an invited plenary lecture at the 2017 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions, San Diego, CA, 13 November, 2017.
14. Tracking global changes in greenhouse gases concentrations at NOAA: What have we learned? Presented at the 2<sup>nd</sup> International Technical Workshop on Climate Risk, Kennebunkport, Maine, Oct 2017 (remotely presented).
15. The value and limitations of global air-sampling networks for improving our understanding trace gas behavior, invited talk at the 2016 Fall AGU meeting, San Francisco, CA, December 2016.
16. "Probing broad-scale atmospheric observations for clues to unraveling the carbon tetrachloride conundrum", invited Keynote speaker at the SPARC Activity Workshop: "Solving the Mystery of Carbon Tetrachloride", Dubendorf, Switzerland, 4-5 Oct, 2015.
17. "Methyl Bromide in the Atmosphere—A Scientific Overview and Update", an invited plenary lecture at the 2015 Annual International Research Conference on

Methyl Bromide Alternatives and Emissions Reductions, San Diego, CA, 9 November, 2015.

18. "Characterizing regional- to global-scale concentrations of short-lived halocarbons", presented by invitation at Harvard University's Environmental Sciences and Engineering Spring 2015 Seminar Series, 20 Feb 2015.
19. "Science of HFCs: High HFC growth from scenarios confirmed by atmospheric sampling", presented by invitation as a side event to the 26<sup>th</sup> Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, 18 Nov 2014, Paris, France.
20. "Recent trends in global concentrations and emissions of hydrochlorofluorocarbons and hydrofluorocarbons", presented by invitation at EMPA, 12 May 2014, Duebendorf, Switzerland.
21. "Global changes in atmospheric concentrations of hydrochlorofluorocarbons and hydrofluorocarbons: assessing and guiding international policy decisions", invited presentation at the 2013 Fall AGU meeting, San Francisco, CA.
22. "Characterizing background atmospheric concentrations of short-lived halocarbons", invited presentation 4 March 2013 as part of the NCAR Spring 2013 Seminar Series, National Center for Atmospheric Research, Boulder, CO.
23. "Shorter-lived trace-gases: opportunities for mitigating ozone depletion and climate change", invited presentation 17 October 2012 as part of the Univ. of California Irvine Fall 2012 seminar series, Univ. of California, Irvine
24. "HFCs in the Atmosphere: Concentrations, Emissions and Impacts" invited plenary presentation given at the joint American Society of Heating Refrigeration Air-conditioning Engineers/NIST Refrigerants Conference, Gaithersburg, October, 2012.
25. "Shorter-lived trace-gases: opportunities for mitigating ozone depletion and climate change", invited presentation 10 Sep 2012 as part of the Univ. of Colorado's INSTAAR Fall seminar series, Univ. of Colorado, Boulder.
26. "Monitoring the progress of the Montreal Protocol and implications for effectively controlling greenhouse gases" invited plenary talk given at the International Year of Chemistry Ozone Symposium on Stratospheric Ozone and Climate Change, Washington, D.C., November 2011.
27. "Methyl Bromide in the Atmosphere – A Scientific Overview and Update" invited plenary talk in the 2012 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions, San Diego, CA, 31 Oct 2011.
28. "Shorter-lived trace-gases: opportunities for mitigating ozone depletion and climate change", invited presentation 25 Oct 2011 as part of the Berkeley Atmospheric Sciences Consortium Fall seminar series, Univ. of California, Berkeley.
29. "Shorter-lived trace-gases: opportunities for mitigating ozone depletion and climate change", invited presentation 30 Sept 2011 as part of the University of Colorado Dept of Atmospheric and Oceanic Sciences Fall 2011 Seminar Series.
30. "Recent increases in global HFC-23 emissions", invited presentation given at the "U.S. Stakeholder Meeting for 2010 Activities under the Montreal Protocol", hosted by the Department of State and Environmental Protection Agency, Washington, D.C., 29 Jan 2010.

31. "A new view of carbonyl sulfide (COS) and its relation to CO<sub>2</sub>", invited presentation at the NOAA Senior Research Council annual meeting, Washington, DC, 12 Jan 2010.
32. "The impact of bromine and QPS emissions on the ozone layer", invited talk given at the Workshop on Methyl Bromide use for quarantine and pre-shipment purposes, UNEP 40<sup>th</sup> meeting of the parties to the Montreal Protocol, Port Ghalib, Egypt, November 2009.
33. "Methyl bromide in the atmosphere—a scientific overview and update", invited plenary talk given at the Methyl Bromide Alternatives Outreach annual meeting, Orlando, November 2008.
34. "Monitoring the Progress of the Montreal Protocol", invited presentation given at the 2008 Quadrennial Ozone Symposium, Tromso, Norway, 1 July 2008.
35. "Interannual variability in atmospheric hydroxyl as inferred from measurements of CH<sub>3</sub>CCl<sub>3</sub>, CH<sub>4</sub>, and other trace gases" invited presentation given at the Fall AGU meeting, San Francisco, December, 2007.
36. "Methyl bromide in the atmosphere—a scientific overview and update", invited plenary talk given at the Methyl Bromide Alternatives Outreach annual meeting, San Diego, CA, October 2007.
37. "A decade of firn air sampling in the polar regions of both hemispheres", invited talk presented at the European Geophysical Society Spring meeting, Vienna, Austria, April 2006.
38. "The atmospheric distribution of carbonyl sulfide and its similarity to CO<sub>2</sub>", invited talk given at Harvard University, Cambridge, 21 October, 2005.
39. "The contribution of NOAA CMDL ground-based measurements to understanding long-term stratospheric changes". Invited presentation given at the Spring AGU meeting, New Orleans, May, 2005.
40. "Seasonal variations in near-surface firn air: Are trace gases incorporated into South Pole firn without artifacts?" Invited presentation given at the European Geophysical Society Spring meeting, Nice, France, April 2004.
41. "Exploring the similar atmospheric variability of carbonyl sulfide and CO<sub>2</sub>", invited seminar presented at the University of California Irvine, January 2004.
42. "Atmospheric measurements of emitted HFCs" invited talk given at the American Society of Heating Refrigeration Air-conditioning Engineers, Anaheim, CA, January 2004.
43. "New constraints for atmospheric hydroxyl from measurements of methyl chloroform" invited talk given at the University of Utrecht, Utrecht, the Netherlands, May 25, 2000.
44. "Insights from halocarbon measurements and monitoring at NOAA/CMDL" invited presentation at the NOAA Global and Climate Change Program review, Philadelphia, PA, February, 1998.
45. "Changes in halocarbon concentrations in recent time: Will the tropospheric abundance of chlorine and 'equivalent' chlorine continue to decline?" Invited talk presented at Harvard University, Cambridge, MA, October 6, 1997.
46. "Canister sampling and quadrupole GC-MS detection of halocarbons in ambient air" invited talk presented at the 24<sup>th</sup> annual conference of the Federation of

Analytical Chemistry and Spectroscopy Societies, Providence RI, October 30, 1997.

## **VII. Conference Proceedings, Technical Reports, and Book Chapters:**

1. Harris, N. R. P.; Montzka, S. A.; Newman, P. A. SPARC, Stratosphere-Troposphere Processes And their Role in Climate, Newsletter no. 53, July 2019. Report on the International Symposium on the Unexpected Increase in Emissions of Ozone-Depleting CFC-11; Vienna, 2019 (<https://www.sparc-climate.org/publications/newsletter/sparc-newsletter-no-53/>).
2. Montzka, S.A., Tracking global changes in greenhouse gas concentrations, Chapter 2 in: *The perils of climate risk: The people and the science*, Cambridge Scholars Publishing, UK, C. LaBlanc, Ed., 2019.
3. Montzka, S.A., C. Siso, D. Mondeel, B. R. Miller, B. D. Hall, J. W. Elkins, and J. H. Butler, Flask sample measurements by the HATS Group of NOAA/ESRL/GMD, on samples collected at Cape Grim, Tasmania. In: *Baseline Atmospheric Program Australia 2011 - 2013*, Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne, xx-xx, 2018.
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### **IX. Panels and Committees Served on:**

1. CIRES Career Track Review Committee panel member, 2020-2021.
2. Consulting expert to the WMO/UNEP Technology and Economic Assessment Panel Task Force on Unexpected Emissions of CFC-11, 2019-2021.
3. U.S. representative (with K. Jucks, NASA) to the 10<sup>th</sup> UNEP meeting of the Ozone Research Managers of the parties to the Vienna Convention of the Montreal Protocol (Geneva, March, 2017).
4. U.S. representative (with K. Jucks, NASA) to the 9<sup>th</sup> UNEP meeting of the Ozone Research Managers of the parties to the Vienna Convention of the Montreal Protocol (Geneva, May, 2014).
5. CIRES Executive Committee Member, 2012-2013.
6. Review panel member of proposals for the German “Conference of Science-driven evaluation of Large Research Infrastructure Projects for a National Roadmap (Pilotphase)”, 16-17 April, 2012, Berlin, Germany.
7. NASA UARP Proposal Review Panel member, 19-20 Oct, 2011.
8. European Commission Research Directorate-General Starting Grants Evaluation Panel for Earth System Science, August, 2007.

### **X. Professional Societies:**

American Geophysical Union  
 American Association for the Advancement of Science

### **XI. Science Advisor to:**

Dr. Lei Hu, CIRES Research Scientist II (2012-present)  
 Ms. Carolina Siso, CIRES Associate Scientist III (2007-present)  
 Dr. Mindy Nicewonger, NRC Postdoctoral Fellow (Oct. 2019-present)  
 Dr. Isaac Vimont, CIRES Research Scientist II (2020-present)  
 Mr. Matt Gentry, CIRES Associate Scientist II (2020-present)  
 Mr. David Nance, CIRES Associate Scientist III

### **XI. Recent extended visitors to the Montzka lab:**

Prof. Dan Yakir, Weizmann Institute, Israel, summer of 2012 (CIRES Senior Visiting Fellow).

Prof. Michela Maione, Univ. of Urbino, Italy, summer of 2013.

Prof. Michela Maione, Univ. of Urbino, Italy, summer of 2014.

Prof. Manual Gloor, Univ of Leeds, UK (with S. Benjamin and J. Miller), summer of 2014 (CIRES).

Stijn Naus, as a graduate student, Univ. Wageningen, summer 2017.

Prof. William Sturges, Univ of East Anglia, Fall 2018 (CIRES Senior Visiting Fellow).

Mr. Bart Croes, former Chief of the Research Division for the California Air Resources Board, summer 2021 (CIRES Senior Visiting Fellow; joint with J. DeGouw).

Dr. Luke Western, winner of the European Commission's Marie Curie Fellowship, Fall 2021 – Fall 2023.

## **XII. Selected media coverage of Montzka and HATS group activities:**

Related to the 2018 paper in *Nature* on CFC-11, viewable [here](#) (Montzka et al.), and the follow-up papers in *Nature* [here](#) (Rigby et al., 2019; Montzka et al., 2021; Park et al., 2021).

- <https://www.nytimes.com/2018/05/16/climate/ozone-layer-cfc.html?partner=rss&emc=rss>
- <https://www.nytimes.com/2019/05/22/climate/china-cfcs-banned-chemicals-ozone.html>
- <https://www.theguardian.com/environment/2018/may/16/mysterious-rise-in-banned-ozone-destroying-chemical-shocks-scientists>
- <https://www.bbc.com/news/science-environment-48353341>
- [https://www.washingtonpost.com/news/energy-environment/wp/2018/05/16/someone-somewhere-is-making-a-banned-chemical-that-destroys-the-ozone-layer-scientists-suspect/?utm\\_term=.a2086b739b1b](https://www.washingtonpost.com/news/energy-environment/wp/2018/05/16/someone-somewhere-is-making-a-banned-chemical-that-destroys-the-ozone-layer-scientists-suspect/?utm_term=.a2086b739b1b)
- <https://podcast-a.akamaihd.net/mp3/podcasts/quirksaio-Qt4NsX7T-20180525.mp3> (extended ratio interview)

**Other media coverage** (CFC-11 paper's Altmetric score of 2250 as of Mar 2021):

- <https://www.climate.gov/tags/steven-montzka>
- or <https://www.climate.gov/news-features/climate-tech/bottled-air-all-over-world-tells-story-ozone-depleting-gases-and-their>
- <http://cires.colorado.edu/news/press/recent-adjustments-montreal-protocol>
- <http://research.noaa.gov/News/NewsArchive/LatestNews/TabId/684/ArtMID/1768/ArticleID/10744/NOAA-Scientists-Contribute-to-2014-Ozone-Depletion-Assessment.aspx>
- [http://www.esrl.noaa.gov/news/quarterly/fall2009/profile\\_stephen\\_a\\_montzka.html](http://www.esrl.noaa.gov/news/quarterly/fall2009/profile_stephen_a_montzka.html)

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**Media coverage related to our CFC-11 paper published May, 2018:**

Related to the recently published paper on CFC-11 paper:

In the New York Times:

<https://www.nytimes.com/2018/05/16/climate/ozone-layer-cfc.html>

<https://www.nytimes.com/2018/06/24/world/asia/china-ozone-cfc.html>

<https://www.nytimes.com/2018/11/03/climate/china-ozone-cfcs.html>

<https://www.nytimes.com/2019/05/22/climate/china-cfcs-banned-chemicals-ozone.html>

<https://www.nytimes.com/2019/11/04/climate/china-cfcs.html>

Related feature and news articles in Nature:

<https://www.nature.com/articles/d41586-018-05110-3> (Hegglin, May 2018)

<https://www.nature.com/articles/d41586-019-01647-z> (Tollefson, May 2019)

<https://www.nature.com/articles/d41586-019-02109-2> (Cyranoski, July 2019)

<https://www.nature.com/articles/d41586-020-00110-8> (Palmer, January 2020)

In other news outlets:

<https://www.theguardian.com/environment/2018/may/16/mysterious-rise-in-banned-ozone-destroying-chemical-shocks-scientists>

[https://www.washingtonpost.com/news/energy-environment/wp/2018/05/16/someone-somewhere-is-making-a-banned-chemical-that-destroys-the-ozone-layer-scientists-suspect/?utm\\_term=.a2086b739b1b](https://www.washingtonpost.com/news/energy-environment/wp/2018/05/16/someone-somewhere-is-making-a-banned-chemical-that-destroys-the-ozone-layer-scientists-suspect/?utm_term=.a2086b739b1b)

A related radio interview:

<https://podcast-a.akamaihd.net/mp3/podcasts/quirksaio-Qt4NsX7T-20180525.mp3>

**Video by the United Nations Environment Program on “the vital work carried out by the Assessment Panels” to the Montreal Protocol:**

<https://ozone.unep.org/spotlight-vital-work-carried-out-assessment-panels>

**Video from the 2019 Governor’s Awards for High Impact Research:**

[https://www.youtube.com/watch?v=eV5Ad839TNk&list=PL6buriUJ4t4TzZfxjGRA\\_h9ZC5A21K3JA&index=3](https://www.youtube.com/watch?v=eV5Ad839TNk&list=PL6buriUJ4t4TzZfxjGRA_h9ZC5A21K3JA&index=3)

**Media coverage of 2021 papers on CFC-11:**

<https://www.nytimes.com/2021/02/10/climate/ozone-layer-china-cfcs.html> (NY Times)

<https://www.nature.com/articles/d41586-021-00360-0> (Tollefson, February 2021)

**CIRES Fellow's web page:**

<http://cires.colorado.edu/about/organization/fellows/stephen-montzka/>

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