

## TODD SOWERS

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### Education

- Ph.D. 1991 Oceanography, University of Rhode Island Graduate School of Oceanography, Dr. Michael Bender, advisor.  
M.S. 1987 Oceanography, University of Rhode Island Graduate School of Oceanography, Dr. Michael Bender, advisor.  
B.S. 1983 Chemistry, Arizona State University, Tempe, Arizona

### Professional Experience

- 2015 - Senior Scientist  
2006- 2015 Senior research associate at the Pennsylvania State University  
2001- 2006 Associate research scientist at the Pennsylvania State University  
1995- 2001 Assistant professor at the Pennsylvania State University  
1993-1995 Postdoctoral research fellow at the Lamont-Doherty Earth Observatory.  
1991-1993 Assistant marine scientist at the University of Rhode Island Graduate School of Oceanography.  
1985-1991 Graduate research assistant.

### Field Experience

- 2009 Co-PI on South Pole firn air experiment  
2008-2010 Three 5week summer deployments to NEEM camp to perform microbiology.  
2006 PI for multi US institution NSF project to sample firn air from West Antarctic Ice core deep drilling site (WAIS)  
2003 PI on 2 month deep field trip to Mt. Moulton  
1997 Expedition to summit (6,250masl) of El Navado Sajama, Bolivia to drill ice cores. Led by Lonnie Thompson. .  
1989-95 Three summer trips to various Antarctic stations (Vostok, Pole). Co-chief scientist on one expedition to Vostok (92/93)  
1989-92 Three summer trips to Summit, Greenland (GISP II)

### Single Authored Publications in Refereed Journals (3)

- Sowers, T. A. (2010). "Atmospheric methane isotope records covering the Holocene period." Quaternary Science Reviews **29**: 213-221, 10.1016/j.quascirev.2009.05.023.  
Sowers, T. (2006). "Late Quaternary atmospheric CH<sub>4</sub> isotope record suggests marine clathrates are stable." Science **311**: 838-841.  
Sowers, T. (2001). The N<sub>2</sub>O record spanning the penultimate deglaciation from the Vostok ice core." Journal of Geophysical Research **106**(D23): 31,903-31,914.

### First Authored Publications in Refereed Journals (10)

- Sowers, T., S. Bernard, O. Aballain, J. Chappellaz, J.-M. Barnola and T. Marik (2005). "Records of the  $\delta^{13}\text{C}$  of atmospheric  $\text{CH}_4$  over the last two centuries as recorded in Antarctic snow and ice." Global Biogeochemical Cycles **19**(GB2002)doi:10.1029/2004GB002408.
- Sowers, T., R. B. Alley and J. Jubenville (2003). "Elemental and isotopic records of atmospheric nitrous oxide covering the last 106,000 years from the GISP II and Taylor Dome ice cores." Science **301**: 945-948.
- Sowers, T., A. Rodebaugh, N. Yoshida and S. Toyoda (2002). "Extending records of the isotopic composition of atmospheric  $\text{N}_2\text{O}$  back to 1800 A. D. from air trapped in snow at South Pole and the Greenland Ice Sheet Project II ice core." Global Biogeochemical Cycles **16**(no.4): doi:1029/2002GB001911.
- Sowers, T. A. and J. Jubenville (2000). "A modified extraction technique for liberating occluded gases in ice cores." Journal of Geophysical Research **105**(D23): 29,155-29,164
- Sowers, T. A. et al., An inter-laboratory comparison of techniques for extracting and analyzing trapped gases in ice cores, *Journal of Geophysical Research*, **102**, 26,527-26,539, 1997
- Sowers, T. and M. Bender, Climate records covering the last deglaciation, *Science* **269**, 210-214, 1995.
- Sowers, T., M. Bender, L. Labeyrie, D. Martinson, J. Jouzel, D. Raynaud, and Y. S. Korotkevich, 135,000 Year Vostok-SPECMAP Common Temporal Framework, *Paleoceanography*, **6**, 867-875, 1993
- Sowers, T., M. Bender, D. Raynaud, and Y. S. Korotkevich, The  $\delta^{15}\text{N}$  of  $\text{N}_2$  in air trapped in polar ice: a tracer of gas transport in the firn and a possible constraint on ice age-gas age differences, *Journal of Geophysical Research*, **97**, 15,683-15,697, 1992.
- Sowers, T., M. Bender, D. Raynaud, Y. S. Korotkevich, and J. Orchardo, The  $\delta^{18}\text{O}$  of atmospheric  $\text{O}_2$  from air inclusions in the Vostok ice core: Timing of  $\text{CO}_2$  and ice volume changes during the penultimate deglaciation, *Paleoceanography*, **6**, 679-696, 1991.
- Sowers, T. A., M. L. Bender, and D. Raynaud, Elemental and isotopic composition of occluded  $\text{O}_2$  and  $\text{N}_2$  in polar ice, *Journal of Geophysical Research*, **94**, 5137-5150, 1989

## All other Publications in Refereed Journals

2013:

- Buizert, C., T. Sowers and T. Blunier (2013). "Assessment of diffusive isotopic fractionation in polar firn, and application to ice core trace gas records." Earth and Planetary Science Letters **361**: 110-119, 10.1016/j.epsl.2012.11.039.
- Dahl-Jensen, D., M. R. Albert, A. Aldahan, N. Azuma, D. Balslev-Clausen, M. Baumgartner, A. M. Berggren, M. Bigler, T. Binder, T. Blunier, J. C. Bourgeois, E. J. Brook, S. L. Buchardt, C. Buizert, E. Capron, J. Chappellaz, J. Chung, H. B. Clausen, I. Cvijanovic, S. M. Davies, P. Ditlevsen, O. Eicher, H. Fischer, D. A. Fisher, L. G. Fleet, G. Gfeller, V. Gkinis, S. Gogineni, K. Goto-Azuma, A. Grinsted, H. Gudlaugsdottir, M. Guillevic, S. B. Hansen, M. Hansson, M. Hirabayashi, S. Hong, S. D. Hur, P. Huybrechts, C. S. Hvidberg, Y. Iizuka, T. Jenk, S. J. Johnsen, T. R. Jones, J. Jouzel, N. B. Karlsson, K. Kawamura, K. Keegan, E. Kettner, S. Kipfstuhl, H. A. Kjaer, M. Koutnik, T. Kuramoto, P. Kohler, T. Laepple, A. Landais, P. L. Langen, L. B. Larsen, D. Leuenberger, M. Leuenberger, C. Leuschen, J. Li, V. Lipenkov, P. Martinerie, O. J. Maselli, V. Masson-Delmotte, J. R. McConnell, H. Miller, O. Mini, A. Miyamoto, M. Montagnat-Rentier, R. Mulvaney, R. Muscheler, A. J. Orsi, J. Paden, C. Panton, F. Pattyn, J. R. Petit, K. Pol, T. Popp, G. Possnert, F. Prie, M. Prokopiou, A. Quiquet, S. O. Rasmussen, D. Raynaud, J. Ren, C. Reutenauer, C. Ritz, T. Rockmann, J. L. Rosen, M. Rubino, O. Rybak, D. Samyn, C. J. Sapart, A. Schilt, A. M. Z. Schmidt, J. Schwander, S. Schupbach, I. Seierstad, J. P. Severinghaus, S. Sheldon, S. B. Simonsen, J. Sjolte, A. M. Solgaard, T. Sowers, P. Sperlich, H. C. Steen-Larsen, K. Steffen, J. P. Steffensen, D. Steinhage, T. F. Stocker, C. Stowasser, A. S. Sturevik, W. T. Sturges, A. Sveinbjornsdottir, A. Svensson, J. L. Tison, J. Uetake, P. Vallelonga, R. S. W. van de Wal, G. van der Wel, B. H. Vaughn, B. Vinther, E. Waddington, A. Wegner, I. Weikusat, J. W. C. White, F. Wilhelms, M. Winstrup, E. Witrant, E. W. Wolff, C. Xiao, J. Zheng and N. Community (2013). "Eemian interglacial reconstructed from a Greenland folded ice core." Nature **493**(7433): 489-494, 10.1038/nature11789.
- Members, W. D. P., T. J. Fudge, E. J. Steig, B. R. Markle, S. W. Schoenemann, Q. Ding, K. C. Taylor, J. R. McConnell, E. J. Brook, T. Sowers, J. W. White, R. B. Alley, H. Cheng, G. D. Clow, J. Cole-Dai, H. Conway, K. M. Cuffey, J. S. Edwards, R. Lawrence Edwards, R. Edwards, J. M. Fegyveresi, D. Ferris, J. J. Fitzpatrick, J. Johnson, G. Hargreaves, J. E. Lee, O. J. Maselli, W. Mason, K. C. McGwire, L. E. Mitchell, N. Mortensen, P. Neff, A. J. Orsi, T. J. Popp, A. J. Schauer, J. P. Severinghaus, M. Sigl, M. K. Spencer, B. H. Vaughn, D. E. Voigt, E. D. Waddington, X. Wang and G. J. Wong (2013). "Onset of deglacial warming in West Antarctica driven by local orbital forcing." Nature 10.1038/nature12376.
- Möller, L., T. Sowers, M. Bock, R. Spahni, M. Behrens, J. Schmitt, H. Miller and H. Fischer (2013). "Independent variations of CH<sub>4</sub> emissions and isotopic composition over the past 160,000 years." Nature Geoscience 10.1038/ngeo1922.
- Schmitt, J., B. Seth, M. Bock, C. van der Veen, L. Moller, C. J. Sapart, M. Prokopiou, T. Sowers, T. Rockmann and H. Fischer (2013). "On the interference of Kr during carbon isotope analysis of methane using continuous-flow combustion-isotope ratio mass spectrometry." Atmospheric Measurement Techniques **6**(5): 1425-1445, 10.5194/amt-6-1425-2013.

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- Buizert, C., P. Martinerie, V. V. Petrenko, J. P. Severinghaus, C. M. Trudinger, E. Witrant, J. L. Rosen, A. J. Orsi, M. Rubino, D. M. Etheridge, L. P. Steele, C. Hogan, J. C. Laube, W. T. Sturges, V. A. Levchenko, A. M. Smith, I. Levin, T. J. Conway, E. J. Dlugokencky, P. M. Lang, K. Kawamura, T. M. Jenk, J. W. C. White, T. Sowers, J. Schwander and T. Blunier (2012). "Gas transport in firn: multiple-tracer characterisation and model intercomparison for NEEM, Northern Greenland." Atmospheric Chemistry and Physics **12**(9): 4259-4277, 10.5194/acp-12-4259-2012.
- Sapart, C. J., G. Monteil, M. Prokopiou, R. S. W. van de Wal, J. O. Kaplan, P. Sperlich, K. M. Krumhardt, C. van der Veen, S. Houweling, M. C. Krol, T. Blunier, T. Sowers, P. Martinerie, E. Witrant, D. Dahl-Jensen and T. Rockmann (2012). "Natural and anthropogenic variations in methane sources during the past two millennia." Nature **490**(7418): 85-88, 10.1038/nature11461.

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- Battle, M. O., J. P. Severinghaus, E. D. Sofen, D. Plotkin, A. J. Orsi, M. Aydin, S. A. Montzka, T. Sowers and P. P. Tans (2011). "Controls on the movement and composition of firn air at the West Antarctic Ice Sheet Divide." Atmospheric Chemistry and Physics **11**(21): 11007-11021, 10.5194/acp-11-11007-2011.
- Mitchell, L. E., E. J. Brook, T. Sowers, J. R. McConnell and K. Taylor (2011). "Multidecadal variability of atmospheric methane, 1000-1800 CE." Journal of Geophysical Research-Biogeosciences **116**: 16, 10.1029/2010jg001441.
- Sapart, C. J., C. van der Veen, I. Vigano, M. Brass, R. S. W. van de Wal, M. Bock, H. Fischer, T. Sowers, C. Buizert, P. Sperlich, T. Blunier, M. Behrens, J. Schmitt, B. Seth and T. Rockmann (2011). "Simultaneous stable isotope analysis of methane and nitrous oxide on ice core samples." Atmospheric Measurement Techniques **4**(12): 2607-2618, 10.5194/amt-4-2607-2011.

2010

- Sowers, T. (2010). "Atmospheric methane isotope records covering the Holocene period." Quaternary Science Reviews **29**(1-2): 213-221, 10.1016/j.quascirev.2009.05.023.

2009

- Mischler, J. A., T. A. Sowers, R. B. Alley, M. Battle, J. R. McConnell, L. Mitchell, T. Popp, E. Sofen and M. K. Spencer (2009). "Carbon and hydrogen isotopic composition of methane over the last 1000 years." Global Biogeochemical Cycles **23**: 13, 10.1029/2009gb003460.
- Miteva, V., C. Teacher, T. Sowers and J. Brenchley (2009). "Comparison of the microbial diversity at different depths of the GISP2 Greenland ice core in relationship to deposition climates." Environmental Microbiology **11**(3): 640-656, 10.1111/j.1462-2920.2008.01835.x.

2007

- Miteva, V., T. Sowers and J. Brenchley (2007). "Production of N<sub>2</sub>O by ammonia oxidizing bacteria at subfreezing temperatures as a model for assessing the N<sub>2</sub>O anomalies in the vostok ice core." Geomicrobiology Journal **24**(5): 451-459, 10.1080/01490450701437693

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Sowers, T. (2006). "Late quaternary atmospheric CH<sub>4</sub> isotope record suggests marine clathrates are stable." Science **311**(5762): 838-840, 10.1126/science.1121235.

2005

Sowers, T., S. Bernard, O. Aballain, J. Chappellaz, J. M. Barnola and T. Marik (2005). "Records of the delta C-13 of atmospheric CH<sub>4</sub> over the last 2 centuries as recorded in Antarctic snow and ice." Global Biogeochemical Cycles **19**(2): 14, 10.1029/2004gb002408.

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Price, P. B. and T. Sowers (2004). "Temperature dependence of metabolic rates for microbial growth, maintenance, and survival." Proceedings of the National Academy of Sciences of the United States of America **101**(13): 4631-4636, 10.1073/pnas.0400522101

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Campen, R. K., T. Sowers and R. B. Alley (2003). "Evidence of microbial consortia metabolizing within a low-latitude mountain glacier." Geology **31**(3): 231-234, 10.1130/0091-7613(2003)031<0231:eomcmw>2.0.co;2

Sowers, T., R. B. Alley and J. Jubenville (2003). "Ice core records of atmospheric N<sub>2</sub>O covering the last 106,000 years." Science **301**(5635): 945-948, 10.1126/science.1085293.

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2001

Sowers, T. (2001). "N<sub>2</sub>O record spanning the penultimate deglaciation from the Vostok ice core." Journal of Geophysical Research-Atmospheres **106**(D23): 31903-31914, 10.1029/2000jd900707.

2000

Sowers, T. and J. Jubenville (2000). "A modified extraction technique for liberating occluded gases from ice cores." Journal of Geophysical Research-Atmospheres **105**(D23): 29155-29164, 10.1029/2000jd900335.

1998

Severinghaus, J. P., T. Sowers, E. J. Brook, R. B. Alley and M. L. Bender (1998). "Timing of abrupt climate change at the end of the Younger Dryas interval from thermally fractionated gases in polar ice." Nature **391**(6663): 141-146, 10.1038/34346.

Thompson, L. G., M. E. Davis, E. Mosley-Thompson, T. A. Sowers, K. A. Henderson, V. S. Zagorodnov, P. N. Lin, V. N. Mikhalenko, R. K. Campen, J. F. Bolzan, J. Cole-Dai and B. Francou (1998). "A 25,000-year tropical climate history from Bolivian ice cores." Science **282**(5395): 1858-1864, 10.1126/science.282.5395.1858.

1997

Alley, R. B., P. A. Mayewski, T. Sowers, M. Stuiver, K. C. Taylor and P. U. Clark (1997).

"Holocene climatic instability: A prominent, widespread event 8200 yr ago." Geology **25**(6): 483-486, 10.1130/0091-7613(1997)025<0483:hciapw>2.3.co;2.

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10.1073/pnas.94.16.8343.

Schwander, J., T. Sowers, J. M. Barnola, T. Blunier, A. Fuchs and B. Malaize (1997). "Age scale of the air in the summit ice: Implication for glacial-interglacial temperature change."

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Sowers, T., E. Brook, D. Etheridge, T. Blunier, A. Fuchs, M. Leuenberger, J. Chappellaz, J. M. Barnola, M. Wahlen, B. Deck and C. Weyhenmeyer (1997). "An interlaboratory comparison of techniques for extracting and analyzing trapped gases in ice cores."

Journal of Geophysical Research-Oceans **102**(C12): 26527-26538, 10.1029/97jc00633.

1996

Battle, M., M. Bender, T. Sowers, P. P. Tans, J. H. Butler, J. W. Elkins, J. T. Ellis, T. Conway, N. Zhang, P. Lang and A. D. Clarke (1996). "Atmospheric gas concentrations over the past century measured in air from firn at the South Pole."

Nature **383**(6597): 231-235,

10.1038/383231a0.

Brook, E. J., T. Sowers and J. Orchardo (1996). "Rapid variations in atmospheric methane concentration during the past 110,000 years." Science **273**(5278): 1087-1091,

10.1126/science.273.5278.1087.

Jouzel, J., C. Waelbroeck, B. Malaize, M. Bender, J. R. Petit, M. Stievenard, N. I. Barkov, J. M. Barnola, T. King, V. M. Kotlyakov, V. Lipenkov, C. Lorius, D. Raynaud, C. Ritz and T. Sowers (1996). "Climatic interpretation of the recently extended Vostok ice records."

Climate Dynamics **12**(8): 513-521, 10.1007/bf00207935.

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Bender, M., T. Sowers and V. Lipenkov (1995). "ON THE CONCENTRATIONS OF O-2, N-2, AND AR IN TRAPPED GASES FROM ICE CORES." Journal of Geophysical Research-Atmospheres **100**(D9): 18651-18660, 10.1029/94jd02212.

Sowers, T. and M. Bender (1995). "CLIMATE RECORDS COVERING THE LAST DEGLACIATION." Science **269**(5221): 210-214, 10.1126/science.269.5221.210.

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Bender, M., T. Sowers, M. L. Dickson, J. Orchardo, P. Grootes, P. A. Mayewski and D. A. Meese (1994). "CLIMATE CORRELATIONS BETWEEN GREENLAND AND

ANTARCTICA DURING THE PAST 100,000 YEARS." Nature **372**(6507): 663-666, 10.1038/372663a0.

Bender, M., T. Sowers and L. Labeyrie (1994). "THE DOLE EFFECT AND ITS VARIATIONS DURING THE LAST 130,000 YEARS AS MEASURED IN THE VOSTOK ICE CORE." Global Biogeochemical Cycles **8**(3): 363-376, 10.1029/94gb00724.

Bender, M. L., T. Sowers, J. M. Barnola and J. Chappellaz (1994). "CHANGES IN THE O-2 N2 RATIO OF THE ATMOSPHERE DURING RECENT DECADES REFLECTED IN THE COMPOSITION OF AIR IN THE FIRN AT VOSTOK STATION, ANTARCTICA." Geophysical Research Letters **21**(3): 189-192, 10.1029/93gl03548.

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1992

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1991

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1988

Craig, H., Y. Horibe and T. Sowers (1988). "GRAVITATIONAL SEPARATION OF GASES AND ISOTOPES IN POLAR ICE CAPS." Science **242**(4886): 1675-1678, 10.1126/science.242.4886.1675

1987

Doering, P. H., J. R. Kelly, C. A. Oviatt and T. Sowers (1987). "EFFECT OF THE HARD CLAM MERCENARIA-MERCENARIA ON BENTHIC FLUXES OF INORGANIC NUTRIENTS AND GASES." Marine Biology **94**(3): 377-383, 10.1007/bf00428243.