

Richard Andrew Wehr, Ph.D.

Research Associate
Department of Ecology and Evolutionary Biology
The University of Arizona

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RESEARCH INTERESTS

1. Biosphere-atmosphere-climate interactions, including exchange of H₂O, CO₂, CH₄, and their isotopes.
2. How the behaviors of fundamental microscopic biogeochemical processes (e.g. photosynthesis, transpiration, methanogenesis) emerge at the ecosystem scale over hours, days, seasons, and years.
3. Development of optical and electronic instrumentation and measurement techniques.

GENERAL: Applying physics to problems in environmental science.

PROFESSIONAL EXPERIENCE

2008-Present

Research Associate

Department of Ecology and Evolutionary Biology, University of Arizona
Supervisor: Prof. S. Saleska

Also: **Associate of the Dept. of Earth and Planetary Sciences**
Harvard University (under Prof. S. C. Wofsy)

Visiting Scientist

Aerodyne Research Inc. (under Dr. M. S. Zahniser)

Partitioning net forest-atmosphere CO₂ exchange into photosynthesis and respiration by isotopic eddy covariance. Study of isotopic CO₂ and CH₄ fluxes in an arctic wetland undergoing thaw, as related to changing microbial populations. Long-term, continuous measurement of isotopic (¹³C and ¹⁸O) CO₂ fluxes using a quantum cascade laser spectrometer. Development of said spectrometer.

2006-2008

Marie Curie Postdoctoral Fellow

Department of Environmental Science, Second University of Naples (Italy)
Supervisor: Prof. L. Gianfrani

Development of an isotope ratio spectrometer based on optical feedback cavity-enhanced absorption spectroscopy. High-accuracy determinations of line strengths, line widths, and spectroscopic temperatures in CO₂.

Sept-Dec. 2005

Postdoctoral Research Fellow

Department of Physics, University of Toronto
Supervisor: Prof. J. R. Drummond

High-resolution line shape spectroscopy in carbon monoxide.

PROFESSIONAL COURSES

- June 2009** **Stable Isotopes in Ecology**
Stable Isotope Ratio Facility for Environmental Research (SIRFER),
Department of Biology, University of Utah
Chief Instructor: Prof. J. Ehleringer
- Lectures on biosphere-atmosphere exchange, C and N cycling, terrestrial H and O isotopic signatures, ocean biogeochemistry, paleoecology, plant-animal interactions, and forensics. Practice in measurement of diverse samples by isotope ratio mass spectrometry and laser spectroscopy.

EDUCATION

- Ph.D.** **University of Toronto, Department of Physics, 2005**
Atmospheric spectroscopy: experimental/theoretical study of the effect of intermolecular collisions on the shapes of high-resolution infrared absorption lines in the atmosphere.
Supervisors: Profs. J. R. Drummond and A. D. May.
Thesis title: "Dicke-narrowed spectral line shapes in CO buffered by Ar".
Courses: Atmospheric Chemistry, Data Assimilation, Air Pollution Formation and Control, Foundations of Geophysics.
- M.Sc.** **University of Toronto, Department of Physics, 2001**
Atmospheric spectroscopy: experimental study of the shapes of high-resolution infrared absorption lines at low (atmospheric) temperatures.
Supervisors: Profs. J. R. Drummond and A. D. May.
Courses: Foundations of Atmospheric Physics, Atmospheric Radiation Transfer, Atmospheric Remote Sensing, Advanced Atmospheric Dynamics.
- Hon.B.Sc.** **Victoria University in the University of Toronto, 2000**
Specialist: Earth Systems: Physics and the Environment.
Minors: English Literature and Mathematics.

HONORS AND AWARDS

- 2006-2008 Marie Curie Fellowship for the Transfer of Knowledge (Postdoctoral)
European Commission (FP6 Marie Curie Actions). €60,732.
- 2006 (declined) UCAR NOAA Climate and Global Change Postdoctoral Fellowship
University Corporation for Atmospheric Research (and National Oceanic and Atmospheric Administration). US\$48,500/year.
- 2003-2005 NSERC Postgraduate Scholarship B
National Sciences and Engineering Research Council of Canada. \$42,000.
- 2002-2003 University of Toronto Fellowship
University of Toronto. \$8,000.
- 2001-2002 University of Toronto Fellowship
University of Toronto. \$7,000.

2000-2001	J. R. G. Smyth Scholarship in Physics <i>University of Toronto. \$2,362.</i>
2000-2001	University of Toronto Fellowship <i>University of Toronto. \$12,000.</i>
1999-2000	Canada Millennium Scholarship <i>Government of Canada. \$3,000.</i>
1999	Undergraduate Student Research Award <i>National Sciences and Engineering Research Council of Canada. \$4,000.</i>
1998-1999	G. David Scott Scholarship <i>Victoria University in the University of Toronto. \$1,000.</i>
1998-1999	Victoria Regents In-Course Scholarship <i>Victoria University in the University of Toronto. \$1,000.</i>
1995-1996	Katherine St. John Scholarship <i>Victoria University in the University of Toronto. \$8,000.</i>

SUCCESSFUL GRANT APPLICATIONS

- 2011-2014** “Partitioning CO₂ fluxes with isotopologue measurements and modeling to understand mechanisms of forest carbon sequestration”, funded by the Department of Energy’s Office of Biological and Environmental Research (Award #DE-SC0006741).
PI: S. R. Saleska; CO-Is: E. Davidson, A. Finzi, P. Moorcroft, R. Wehr

PUBLICATIONS

1. C. McCalley, B. Woodcroft, S. Hodgkins, **R. Wehr**, E.-H. Kim, R. Mondav, P. Crill, J. Chanton, V. Rich, G. Tyson, and S. R. Saleska (2014). Methane dynamics regulated by microbial community response to permafrost thaw. *Nature* 514(7523), 478-481.
2. **R. Wehr** and S. R. Saleska (2014). An improved isotopic method for partitioning net ecosystem-atmosphere CO₂ exchange. In review for *Agricultural and Forest Meteorology*.
3. B. Xiang, D. D. Nelson, J. B. McManus, M. S. Zahniser, **R. Wehr**, and S. C. Wofsy (2014). Development and field testing of a rapid and ultra-stable atmospheric carbon dioxide spectrometer. In review for *Atmospheric Measurement Techniques*.
4. **R. Wehr**, J. W. Munger, D. D. Nelson, J. B. McManus, M. S. Zahniser, S. C. Wofsy, and S. R. Saleska (2013). Long-term eddy covariance measurements of the isotopic composition of the ecosystem-atmosphere exchange of CO₂ in a temperate forest. *Agricultural and Forest Meteorology* 181, 69-84.
5. A.D. May, W.-K. Liu, F.R.W. McCourt, R. Ciurylo, J. Sanchez-Fortún Stoker, D. Shapiro, and **R. Wehr** (2012). The Impact Theory of Spectral Line Shapes: A Paradigm Shift. *Canadian Journal of Physics* 10.1139/cjp-2012-0345.
6. J. B. McManus, M. S. Zahniser, D. D. Nelson, J. H. Shorter, S. Herndon, E. Wood, and **R. Wehr** (2010). Application of quantum cascade lasers to high-precision atmospheric trace gas measurements. *Optical Engineering* 49(11), 111124-111124-11.

7. G. Casa, **R. Wehr**, A. Castrillo, E. Fasci, and L. Gianfrani (2009). The line shape problem in the near-infrared spectrum of self-colliding CO₂ molecules: Experimental investigation and test of semiclassical models. *Journal of Chemical Physics* 130(18), 184306.
8. **R. Wehr**, S. Kassi, D. Romanini, and L. Gianfrani (2008). Optical feedback cavity-enhanced absorption spectroscopy for in situ measurements of the ratio ¹³C:¹²C in CO₂. *Applied Physics B* 92(3), 459-465.
9. G. Casa, A. Castrillo, G. Galzerano, **R. Wehr**, A. Merlone, D. Di Serafino, P. Laporta, and L. Gianfrani (2008). Primary gas thermometry by means of laser-absorption spectroscopy: Determination of the Boltzmann constant. *Physical Review Letters* **100**(20), 200801.
10. G. Casa, D. A. Parretta, A. Castrillo, **R. Wehr**, and L. Gianfrani (2007). Highly accurate determinations of CO₂ line strengths using intensity-stabilized diode laser absorption spectrometry. *Journal of Chemical Physics* 127(8), 084311.
11. **R. Wehr**, J. R. Drummond, and A. D. May (2007). Design of a difference-frequency infrared laser spectrometer for absorption line-shape studies. *Applied Optics* 46(6), 978-85.
12. **R. Wehr**, R. Ciurylo, F. Thibault, A. Vitcu, James R. Drummond and A. D. May (2006). Dicke-narrowed spectral line shapes of CO in Ar: Experimental results and a revised interpretation. *Journal of Molecular Spectroscopy* 235, 54-68.
13. **R. Wehr**, F. Thibault, A. Vitcu, James R. Drummond and A. D. May (2006). Collisional line shifting and broadening in the fundamental P-branch of CO in Ar between 214 K and 324 K. *Journal of Molecular Spectroscopy* 235, 69-76.
14. A. Vitcu, **R. Wehr**, R. Ciurylo, James R. Drummond and A. D. May (2004). High-resolution tunable mid-infrared spectrometer based on difference-frequency generation in AgGaS₂. *Applied Optics* 43(25), 4965-4971.
15. A. Vitcu, R. Ciurylo, **R. Wehr**, J. R. Drummond, and A. D. May (2004). Broadening, shifting, and line mixing in the 03¹0 ← 01¹0 parallel Q branch of N₂O. *Journal of Molecular Spectroscopy* 226, 71-80.
16. **R. Wehr**, E. McKernan, A. Vitcu, R. Ciurylo, and J. R. Drummond (2003). Dynamic spectroscopic measurements of the temperature and pressure cycles in a MOPITT pressure modulator cell. *Applied Optics* 42 (33), 6595-6604.
17. **R. Wehr**, A. Vitcu, R. Ciurylo, F. Thibault, J. R. Drummond, and A. D. May (2002). Spectral line shape of the P(2) transition in CO-Ar: Uncorrelated ab initio calculation. *Physical Review A* 66, 062502.
18. C. Luo, **R. Wehr**, J. R. Drummond, A. D. May, F. Thibault, J. Boissolles, J. M. Launay, C. Boulet, J.-P. Bouanich, and J.-M. Hartmann (2001). Shifting and broadening in the fundamental band of CO highly diluted in He and Ar: A comparison with theory. *Journal of Chemical Physics* 115, 2198-2206.

PRESENTATIONS

Conference Talks (speaker is underlined)

1. **R. A. Wehr**, S. R Saleska, J. W. Munger, M. S Zahniser, J. B. McManus, and D. D Nelson (2014). New Insights on Canopy Photosynthesis from novel Isotopic Flux Partitioning in a temperate forest. *EGU General Assembly 2014*. Vienna, Austria.
2. **R. A. Wehr**, J. W. Munger, J. B. McManus, D. D Nelson, M. S Zahniser, and S. R Saleska (2013). Diel and Seasonal Behavior of Canopy Photosynthesis Revealed by Novel Isotopic Flux Partitioning

- in a Temperate Forest. Accepted for the *2013 American Geophysical Union Fall Meeting*. San Francisco, U.S.A.
3. C. K. McCalley, R. Mondav, B. J. Woodcroft, S. Hodgkins, E.-H. Kim, **R. A. Wehr**, J. P. Chanton, V. I. Rich, P. M. Crill, G. W. Tyson and S. R. Saleska (2012). Methane flux and carbon isotope composition correlate to shifting plant and microbial communities along a permafrost thaw gradient. *2012 American Geophysical Union Fall Meeting*. San Francisco, U.S.A.
 4. **R. Wehr**, J. W. Munger, D. D. Nelson, J. B. McManus, M. S. Zahniser, S. C. Wofsy, and S. R. Saleska (2011). Flux Partitioning by Isotopic Eddy Covariance. *2011 American Geophysical Union Fall Meeting*. San Francisco, U.S.A.
 5. **R. Wehr**, F. Di Gregorio, G. Casa, D. Romanini, A. Castrillo, M.F. Cotrufo, and L. Gianfrani (2009). Measuring $\delta^{13}\text{C}$ in CO_2 by Optical Feedback Cavity-Enhanced Absorption Spectroscopy. *International Conference on Field Laser Applications in Industry and Research*. Grainau, Germany.
 6. **R. Wehr**, D. A. Parretta, D. Romanini, and L. Gianfrani (2007). Optical feedback cavity-enhanced absorption spectroscopy for determining $\delta^{13}\text{C}$ in CO_2 at field sites. *7th Cavity Ringdown User Meeting*. University of Greifswald, Germany.
 7. **R. Wehr**, A. Castrillo, D. A. Parretta, D. Romanini, and L. Gianfrani (2007). Long-path absorption spectrometers for determining $\delta^{13}\text{C}$ in CO_2 at field sites. *International Conference on Field Laser Applications in Industry and Research/International Workshop on Stable Isotope Ratio Infrared Spectroscopy (joint session)*. Florence, Italy.
 8. **R. Wehr**, A. Castrillo, and L. Gianfrani (2007). Long-path absorption techniques for the spectroscopic determination of $\delta^{13}\text{C}$ in CO_2 at field sites. *Mini Symposium on the Use of Stable Isotopes in Tree Physiology and Forest Ecology*. Université Henri Poincaré, Nancy, France.
 9. **R. Wehr**, R. Ciurylo, A. Vitcu, F. Thibault, D. A. Shapiro, W.-K. Liu, F. R. W. McCourt, J. R. Drummond, and A. D. May (2006). Dicke-narrowed line shapes in CO-Ar: Measurements, calculations, and a revised interpretation. *18th International Conference on Spectral Line Shapes*. Auburn University, Alabama, U.S.A.
 10. **R. Wehr**, A. Vitcu, R. Ciurylo, F. Thibault, J. R. Drummond, and A. D. May (2004). The effect of inelastic collisions on the collisional (Dicke) narrowing of spectral line shapes in CO-Ar. *17th International Conference on Spectral Line Shapes*. University of Paris VI, Paris, France.
 11. **R. Wehr**, A. Vitcu, R. Ciurylo, F. Thibault, J. R. Drummond, and A. D. May (2003). CO line shapes: A comparison between *ab initio* calculations and high-resolution measurements. *58th International Symposium on Molecular Spectroscopy*. Ohio State University, Ohio, U.S.A.
 12. **R. Wehr**, A. Vitcu, R. Ciurylo, F. Thibault, J. R. Drummond, and A. D. May (2003). CO line shapes: A comparison between *ab initio* calculations and high-resolution measurements. *2003 Canadian Association of Physicists Congress*. University of Prince Edward Island, Charlottetown, P.E.I., Canada.
 13. **R. Wehr**, E. McKernan, A. Vitcu, R. Ciurylo, and J. R. Drummond (2002). Dynamic spectroscopic measurements of the pressure and temperature cycles in a PMC. *57th International Symposium on Molecular Spectroscopy*. Ohio State University, Ohio, U.S.A.
 14. A. Vitcu, R. Ciurylo, **R. Wehr**, J. R. Drummond, and A. D. May (2002). Self-broadening, shifting and mixing in the $03^1_0 \leftarrow 01^1_0$ Q-branch of N_2O . *57th International Symposium on Molecular Spectroscopy*. Ohio State University, Ohio, U.S.A.
 15. **R. Wehr**, A. Vitcu, R. Ciurylo, F. Thibault, J. R. Drummond, and A. D. May (2002). Comparison of an *ab initio* calculation of the CO-Ar P(2) line shape with high-resolution measurements. *16th*

International Conference on Spectral Line Shapes. University of California at Berkeley, California, U.S.A.

16. A. Vitcu, **R. Wehr**, R. Ciurylo, J.R. Drummond, and A.D. May (2002). High resolution and high signal-to-noise measurements in the $03^1_0 \leftarrow 01^1_0$ Q-branch of N_2O at 1160 cm^{-1} . *16th International Conference on Spectral Line Shapes*. University of California at Berkeley, California, U.S.A.
17. **R. Wehr**, A. Vitcu, R. Ciurylo, J. R. Drummond, and A. D. May (2001). High-resolution measurements of the broadening and shifting of CO-N₂ at low-temperatures. *56th International Symposium on Molecular Spectroscopy*. Ohio State University, Ohio, U.S.A.
18. A. Vitcu, **R. Wehr**, R. Ciurylo, J.R. Drummond, and A.D. May (2001). Tunable infrared spectrometer based on difference-frequency generation in AgGaS₂ for lineshape studies in N_2O . *56th International Symposium on Molecular Spectroscopy*. Ohio State University, Ohio, U.S.A.

Invited Seminars

1. **R. Wehr**. Using Isotopes to Go Beyond Net Ecosystem Exchange of CO₂. Boston University, April 4th, 2012.

Conference Posters

1. E.-H. Kim, B. J. Woodcroft, R. M. Jones, C. K. McCalley, R. Mondav, S. Hodgkins, **R. A. Wehr**, T. Logan, P. M. Crill, J. P. Chanton, S. R. Saleska, G. W. Tyson, N. C. VerBerkmoes, and V. I. Rich (2013). Combining microbial community proteomics and biogeochemistry to understand greenhouse gas emissions from a sentinel habitat of climate change. *American Society for Mass Spectrometry 61st Conference*. Minneapolis, Minnesota, U.S.A.
2. E.-H. Kim, B. J. Woodcroft, R. M. Jones, C. K. McCalley, R. Mondav, S. Hodgkins, **R. A. Wehr**, T. Logan, P. M. Crill, J. P. Chanton, S. R. Saleska, G. W. Tyson, N. C. VerBerkmoes, and V. I. Rich (2013) Microbial carbon cycling across a natural permafrost thaw gradient, via biogeochemistry and metaproteomics-inferred microbial activity. *American Society for Microbiology 113th General Meeting*. Denver, Colorado, U.S.A.
3. E.-H. Kim, B. J. Woodcroft, R. Mondav, C. K. McCalley, R. M. Jones, S. Hodgkins, **R. A. Wehr**, T. Logan, J. P. Chanton, P. M. Crill, N. C. VerBerkmoes, S. R. Saleska, V. I. Rich, and G. W. Tyson (2012). Microbial mediators of carbon fate in thawing permafrost: Connecting microbial activity to geochemistry across an in situ thaw gradient. *2012 American Geophysical Union Fall Meeting*. San Francisco, U.S.A.
4. **R. Wehr**, S. R. Saleska, E. A. Davidson, J. Drake, A. Finzi, P. R. Moorcroft, J. W. Munger, J. B. McManus, D. D. Nelson, K. Savage, S. C. Wofsy, and M. S. Zahniser (2012). Partitioning CO₂ fluxes with isotopologue measurements and modeling to understand mechanisms of forest carbon sequestration. *Harvard Forest Ecology Symposium*. Petersham, Massachusetts, U.S.A.
5. **R. A. Wehr**, J. W. Munger, D. D. Nelson, J. B. McManus, M. S. Zahniser, and S. R. Saleska (2010). Measurements of Forest-Atmosphere Isotopic CO₂ Exchange by Eddy Covariance. *2010 American Geophysical Union Fall Meeting*. San Francisco, U.S.A.
6. G. Casa, D. A. Parretta, A. Castrillo, **R. Wehr**, and L. Gianfrani (2007). An intensity-stabilised diode laser spectrometer for highly accurate line intensity measurements in carbon dioxide spectrum. *20th Colloquium on High Resolution Molecular Spectroscopy*. Université de Bourgogne, Dijon, France.
7. **R. Wehr**, E. McKernan, A. Vitcu, R. Ciurylo, and J. R. Drummond (2004). Dynamic spectroscopic measurements of the pressure and temperature cycles in a MOPITT pressure modulator cell. *2003*

Canadian Association of Physicists Congress. University of Prince Edward Island, Charlottetown, P.E.I., Canada.

8. A. Vitcu, **R Wehr**, R. Ciurylo, J. R. Drummond, and A. D. May (2003). Line shape studies in the $03^1_0 \leftarrow 01^1_0$ Q-branch of N_2O at 1160 cm^{-1} . *2003 Canadian Association of Physicists Congress*. University of Prince Edward Island, Charlottetown, P.E.I, Canada.

TEACHING EXPERIENCE

- 2013-2014** **Harvard University/Harvard Forest**
Mentor for the Research Experience Undergraduate program in Ecology
- 2007** **Second University of Naples**
Guest Lecturer for “Advanced Spectroscopic Methods”
Topic: Cavity-enhanced absorption spectroscopy
- 2000-2005** **University of Toronto**
Teaching Assistant for “Assessing Global Change”
Ran discussion-based tutorials, graded exams and written assignments
- 2001-2004** **University of Toronto**
Teaching Assistant for “Environmental Research”
Co-supervised 4th year group research projects, graded oral/written work
- 2003** **University of Toronto**
Guest Lecturer for “Environmental Research Skills”
Topic: Using surveys as a research instrument, and numerical data analysis
- 2001-2003** **University of Toronto**
Teaching Assistant for “Environmental Research Skills”
Graded written assignments, consulted with students

TECHNICAL SKILLS

Design and assembly of opto-electronic systems in the visible and infrared, including high-finesse optical cavities and multiple-reflection cells. Design and assembly of gas-handling and vacuum systems, and low-temperature gas cells. Basic electronic circuit construction and repair. Use of quantum cascade, tunable diode, tunable dye, and argon ion lasers. Design of instrument control, data acquisition, and data analysis software. Programming in LABVIEW, MATLAB, and IGOR.

SERVICE

Co-Convener of the sessions *Stable Isotope Fluxes in the Carbon and Water Cycles of Terrestrial Ecosystems* and *Laser-Based Isotope Techniques in Biogeosciences* at the AGU Fall 2011 Meeting.

Reviewer for the journals *Environmental Science and Technology*, *Atmospheric Environment*, *Molecular Physics*, and *Rapid Communications in Mass Spectrometry* and **Grant Reviewer** for the *Deutsche Forschungsgemeinschaft* (German Research Foundation).

Member of the American Geophysical Union and the European Geosciences Union.