

USGS Environment-Hydrate References

Selected publications resulting from USGS research on environment-hydrate topics supported in part under DOE Interagency Agreements

USGS-led environment-hydrate research under core Interagency Agreements from 2010 to present-day (citations grouped under regional headings)

Global processes topics:

Ruppel, C. D., & Waite, W. F. (2020). Grand challenge: Timescales and processes of methane hydrate formation and breakdown, with application to geologic systems. *Journal of Geophysical Research: Solid Earth*, 125, e2018JB016459. <https://doi.org/10.1029/2018JB016459>

Ruppel, C. D., & Kessler, J. D. (2017). The interaction of climate change and methane hydrates. *Reviews of Geophysics*, 55(1), 126–168. <https://doi.org/10.1002/2016RG000534>

Ruppel, C. D. (2011). Methane hydrates and contemporary climate change. *Nature Education Knowledge*, 3(10), 29. Available at <http://www.nature.com/scitable/knowledge/library/methane-hydrates-and-contemporary-climate-change-24314790>

Ruppel, C. (2011). USGS Gas hydrates project convenes DOE workshop on climate-gas hydrates interactions, U.S. Dept. of Energy, National Energy Technology Lab, *Fire in the Ice*, 11(1), 18-20. https://www.netl.doe.gov/sites/default/files/publication/MHNews_2011_05.pdf#page=18.

Ruppel, C. and J.W. Pohlman (2008). Climate change and carbon cycle: Perspectives and opportunities, *Fire in the Ice*, DOE/National Energy Technology Lab Gas Hydrates Newsletter, 8(1), pp. 5-8, January 2008. <https://www.netl.doe.gov/sites/default/files/publication/HMNewsWinter08.pdf#page=5>

US Atlantic Margin topics:

Fu, X., Waite, W. F., and Ruppel, C. D. (2021). Hydrate formation on marine seep bubbles and the implications for water column methane dissolution. *Journal of Geophysical Research: Oceans*, 126, e2021JC017363. <https://doi.org/10.1029/2021JC017363>

Ruppel, C. D., Miller, N.C., Frye, M., Baldwin, W., Foster, D., Shedd, W., and Palmes, S. (2019). U.S. Mid-Atlantic Resource Imaging Experiment (MATRIX) Constrains Gas Hydrate Distribution, *Fire in the Ice*, DOE/National Energy Technology Lab Gas Hydrates Newsletter, 19(1), pp. 6-8, Spring 2019. https://www.netl.doe.gov/sites/default/files/publication/MHNews_2019_Spring.pdf#page=6

Ruppel, C., Demopoulos, A., and Prouty, N. (2018). Exploring US Mid-Atlantic Margin Methane Seeps: IMMERSS, May 2017: Supplement to *Oceanography*, 31(1), p. 93.

Prouty, N. G., Sahy, D., Ruppel, C. D., Roark, E. B., Condon, D., Brooke, S., Ross, S. W. and Demopoulos, A. W. J. (2016). Insights into methane dynamics from analysis of authigenic carbonates and chemosynthetic mussels at newly-discovered Atlantic Margin seeps, *Earth Planet. Sci. Lett.*, 449, 332– 344, doi:[10.1016/j.epsl.2016.05.023](https://doi.org/10.1016/j.epsl.2016.05.023)

Skarke, A., Ruppel, C., Kodis, M., Brothers, D., & Lobecker, E. (2014). Widespread methane leakage from the sea floor on the northern US Atlantic margin. *Nature Geoscience*, 7(9), 657–661. <https://doi.org/10.1038/ngeo2232>

Brothers, D. S., Ruppel, C., Kluesner, J. W., ten Brink, U. S., Chaytor, J. D., Hill, J. C., Andrews, B. D., & Flores, C. (2014). Seabed fluid expulsion along the upper slope and outer shelf of the U.S. Atlantic continental margin. *Geophysical Research Letters*, 41, 96–101. <https://doi.org/10.1002/2013GL058048>

Brothers, L. L., C. L. Van Dover, C. R. German, C. L. Kaiser, D. R. Yoerger, C. D. Ruppel, E. Lobecker, A. D. Skarke, and J. K. S. Wagner (2013). Evidence for extensive methane venting on the southeastern U.S. Atlantic margin, *Geology*, G34217(1), doi:[10.1130/g34217.1](https://doi.org/10.1130/g34217.1)

Western Arctic Ocean topics:

Overduin, P. P., Schneider von Deimling, T., Miesner, F., Grigoriev, M. N., Ruppel, C., Vasiliev, A., Lantuit, H., Juhls, B., & Westermann, S. (2019). Submarine Permafrost Map in the Arctic Modeled Using 1-D Transient Heat Flux (SuPerMAP). *Journal of Geophysical Research: Oceans*, 124, 3490– 3507. <https://doi.org/10.1029/2018JC014675>

Sparrow, K., Kessler, J.D., Southon, J.R., Garcia-Tigreros, F., Schreiner, K.M., Ruppel, C.D. Miller, J.B., Lehman, S.J. and Xu, X. (2018). [Limited contribution of ancient methane to surface waters of the U.S. Beaufort Sea](https://doi.org/10.1126/sciadv.aao4842), *Science Advances*, 4. <https://www.science.org/doi/10.1126/sciadv.aao4842>

Brothers, L. L., B. M. Herman, P. E. Hart, and C. D. Ruppel (2016), Subsea ice-bearing permafrost on the U.S. Beaufort Margin: 1. Minimum seaward extent defined from multichannel seismic reflection data, *Geochem. Geophys. Geosyst.*, 17, 4354– 4365, doi:[10.1002/2016GC006584](https://doi.org/10.1002/2016GC006584).

Ruppel, C. D., B. M. Herman, L. L. Brothers, and P. E. Hart (2016). Subsea ice-bearing permafrost on the U.S. Beaufort Margin: 2. Borehole constraints, *Geochem. Geophys. Geosyst.*, 17, 4333– 4353, doi:[10.1002/2016GC006582](https://doi.org/10.1002/2016GC006582).

Ruppel, C., L. Brothers, P. Hart, C. Maue, J. Pohlman, J. Kessler, K.J. Sparrow, and C. Worley, (2012). Methane dynamics associated with long-term climate change on the Alaskan Beaufort Sea inner shelf, U.S. Dept. of Energy, National Energy Technology Lab, *Fire in the Ice*, 12(1), 7-10. https://www.netl.doe.gov/sites/default/files/publication/MHNews_2012_June.pdf

Isaksen, I. S. A., M. Gauss, G. Myhre, K. M. Walter Anthony, and C. Ruppel (2011). Strong atmospheric chemistry feedback to climate warming from Arctic methane emissions, *Global Biogeochem. Cycles*, 25, GB2002, doi:10.1029/2010GB003845

Ruppel, C., (2013). Catching climate change in progress: Drilling on Circum-Arctic Shelves and Upper Continental Slopes, Integrated Ocean Drilling Program/US Science Support Program, Workshop Report, 44 pp.

https://usoceandiscovery.org/wp-content/uploads/2016/05/Workshop_Report_CADW.pdf

Alaska North Slope topics:

He, R., Wang, J., Pohlman, J.W. *et al.* Metabolic flexibility of aerobic methanotrophs under anoxic conditions in Arctic lake sediments. *ISME J* 16, 78–90 (2022).

<https://doi.org/10.1038/s41396-021-01049-y>

Elder, C.D., Xu, X., Walker, J. *et al.* (2018). Greenhouse gas emissions from diverse Arctic Alaskan lakes are dominated by young carbon. *Nature Clim Change* 8, 166–171.

<https://doi.org/10.1038/s41558-017-0066-9>

Elvert, M., Pohlman, J.W., Becker, K.W., Gaglioti, B., Hinrichs, K-U., Wooller, M.J. (2016). Methane turnover and environmental change from Holocene lipid biomarker records in a thermokarst lake in Arctic Alaska. *The Holocene*. 2016;26(11):1766-1777.

doi:[10.1177/0959683616645942](https://doi.org/10.1177/0959683616645942)

Ruppel, C. (2015). Permafrost-associated gas hydrate: Is it really approximately 1 % of the global system?, *J. Chem. Eng. Data*, 60(2), 429– 436, doi:[10.1021/je500770m](https://doi.org/10.1021/je500770m).

Pacific Northwest Margin topics (both US and Canadian portions of margin):

Riedel, M., Collett, T.S., Scherwath, M., Pohlman, J.W., Hyndman, R., and G. Spence (2022). Chapter 8: Northern Cascadia margin gas hydrates – Regional geophysical surveying, IODP drilling leg 311 and cabled observatory monitoring, in: *World Atlas of Submarine Gas Hydrates in Continental Margins*, eds. J. Mienert, C. Berndt, A. Trehu, A. Camerlenghi, and C.S. Liu, Springer Nature Switzerland, 109-120, https://doi.org/10.1007/978-3-030-81186-0_8.

Greinert, J., Weiss, T., Demopoulos, A.W., Danforth, W.W., and C.D. Ruppel (2019). Gas flow offshore Oregon and California, how much is coming out: Results from MBES, SBES, GasQuant, BubbleBox and ROV-based studies during FK190612, AGU Fall Meeting, OS51A-03,

<https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/501399>.

Demopoulos, A., Prouty, N., and C. Ruppel (2020). Seafloor methane seeps at the edge of hydrate stability, Newswave, Dept. of Interior newsletter, pp.20-21.

<https://www.doi.gov/sites/doi.gov/files/uploads/newswave-spring-summer2020.pdf#page=20>

Pohlman, J. W., J. E. Bauer, W. F. Waite, C. L. Osburn, and N. R. Chapman (2011). Methane hydrate-bearing seeps as a source of aged dissolved organic carbon to the oceans, *Nat. Geosci.*, 4(1), 37– 41, doi:[10.1038/Ngeo1016](https://doi.org/10.1038/Ngeo1016).

Northern Gulf of Mexico topics:

Feng, D., Pohlman, J., Peckmann, J, Sun, Y., Hu, Y., Roberts, H. and D. Chen. (2021). Contribution of deep-sourced carbon from hydrocarbon seeps to sedimentary organic carbon: Evidence from radiocarbon and stable isotope geochemistry. *Chemical Geology*. 585. 120572. <https://10.1016/j.chemgeo.2021.120572>.

Fu, X., Waite, W. F., & Ruppel, C. D. (2021). Hydrate formation on marine seep bubbles and the implications for water column methane dissolution. *Journal of Geophysical Research: Oceans*, 126, e2021JC017363. <https://doi.org/10.1029/2021JC017363>

North Sea and Svalbard margin topics:

Pohlman, J., Ruppel, C.D., Casso, M., Weiss, T., and J. Greinert (2019). The atmospheric flux of methane from a North Sea gas field includes a non-seep surface water methane source, AGU Fall Meeting, OS51A-08, <https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/592746>

Pohlman, J., J. Greinert, C. Ruppel, A. Silyakova, L. Vielstadte, M. Casso, J. Mienert, and S. Bunz, (2017). Enhanced CO₂ uptake at a shallow Arctic Ocean seep field overwhelms the positive warming potential of methane, *Proc. Nat. Acad. Sci.*, doi: 10.1073/pnas.1618926114.

Greenland margin/Ellesmere Island topics:

Jakobsson, M., Mayer, L.A., Nilsson, J. *et al.* (2020). Ryder Glacier in northwest Greenland is shielded from warm Atlantic water by a bathymetric sill. *Commun Earth Environ* 1, 45 (2020). <https://doi.org/10.1038/s43247-020-00043-0>

Baltic Sea topics:

Wilson, S. T., Bange, H. W., Arévalo-Martínez, D. L., Barnes, J., Borges, A. V., Brown, I., Bullister, J. L., Burgos, M., Capelle, D. W., Casso, M., de la Paz, M., Farías, L., Fenwick, L., Ferrón, S., Garcia, G., Glockzin, M., Karl, D. M., Kock, A., Laperriere, S., Law, C. S., Manning, C. C., Marriner, A., Myllykangas, J. P., Pohlman, J. W., Rees, A. P., Santoro, A. E., Tortell, P. D., Upstill-Goddard, R. C., Wisegarver, D. P., Zhang, G. L., & Rehder, G. (2018). An intercomparison of oceanic methane and nitrous oxide measurements. *Biogeosciences*, 15(19), 5891-5907. <https://doi.org/10.5194/bg-15-5891-2018>

Western Pacific topics:

Feng, D., Pohlman, J., Peckmann, J., Sun, Y., Hu, Y., Roberts, H. and D. Chen. (2021). Contribution of deep-sourced carbon from hydrocarbon seeps to sedimentary organic carbon: Evidence from radiocarbon and stable isotope geochemistry. *Chemical Geology*. 585. 120572.
<https://10.1016/j.chemgeo.2021.120572>

Laboratory studies:

Hunt, A.G., Stern, L., Pohlman, J.W., Ruppel, C., Moscati, R.J., and Landis, G. (2013). Mass fractionation of noble gases in synthetic methane hydrate: Implications for naturally occurring gas hydrate dissociation, *Chemical Geology*, 339, pp. 242-250, doi: 10.1016/j.chemgeo.2012.09.033.

Pohlman, J.W., Casso, M., Magen, C., and E. Bergeron (2021). Discrete Sample Introduction Module for Quantitative and Isotopic Analysis of Methane and Other Gases by Cavity Ring-Down Spectroscopy, *Environmental Science & Technology* 2021 55 (17), 12066-12074
<https://pubs.acs.org/doi/10.1021/acs.est.1c01386>

Pohlman, J.W., and Casso, M. (2021). Comparison of methane concentration and stable carbon isotope data for natural samples analyzed by discrete sample introduction module - cavity ring down spectroscopy (DSIM-CRDS) and traditional methods: U.S. Geological Survey data release, <https://doi.org/10.5066/P99B34V1>.

USGS environment-hydrate research under collaborative Interagency Agreements on University Awards from DOE (citations grouped by university partner with lead researchers and project titles noted, some citations previously listed above)

Kessler (Rochester)/Ruppel (USGS) – Characterizing ocean acidification and atmospheric emission caused by methane released from gas hydrate systems along the US Atlantic Margin

Kessler, J.D., Ruppel, C.D., Joung, D., Garcia-Tigreros, F., and Leonte, M. (2018). Exploring Impacts of Widespread Seafloor Methane Seepage on Ocean Chemistry and Atmospheric Methane Emissions along the U.S. Mid-Atlantic Margin, *Fire in the Ice*, DOE/National Energy Technology Lab Gas Hydrates Newsletter, 18(1), pp. 4-6, Summer 2018.

https://www.netl.doe.gov/sites/default/files/publication/MHNews_2018_Summer.pdf#page=4

Garcia-Tigreros, F. and J. D. Kessler (2018). Limited acute influence of aerobic methane oxidation on ocean carbon dioxide and pH in Hudson canyon, northern U.S. Atlantic margin. *Journal of Geophysical Research: Biogeosciences*, 123(7), 2135-2144.

<https://doi.org/10.1029/2018JG004384>

Garcia-Tigreros, F., Leonte, M., Ruppel, C. D., Ruiz-Angulo, A., Joung, D. J., Young, B., & Kessler, J. D. (2021). Estimating the impact of seep methane oxidation on ocean pH and dissolved inorganic radiocarbon along the U.S. Mid-Atlantic Bight. *Journal of Geophysical Research: Biogeosciences*, **126**(1), e2019JG005621. <https://doi.org/10.1029/2019JG005621>

Joung, D.-J., Leonte, M., Valentine, D. L., Sparrow, K., Weber, T., & Kessler, J. D. (2020). Radiocarbon in marine methane reveals patchy impact of seeps on surface waters. *Geophysical Research Letters*, 47, e2020GL089516. <https://doi.org/10.1029/2020GL089516>

Joung, D., Ruppel, C., Southon, J., and J. Kessler (2021). Elevated levels of radiocarbon in methane dissolved in seawater reveal likely local contamination from nuclear powered vessels. *Science of The Total Environment*. 806. 150456. 10.1016/j.scitotenv.2021.150456.

Leonte, M., J. D. Kessler, M. Y. Kellermann, E. C. Arrington, D. L. Valentine, and S. P. Sylva (2017). Rapid rates of aerobic methane oxidation at the feather edge of gas hydrate stability in the waters of Hudson Canyon, US Atlantic Margin. *Geochimica et Cosmochimica Acta*, 204, 375-387. <https://doi.org/10.1016/j.gca.2017.01.009>

Leonte, M., B. Wang, S. A. Socolofsky, S. Mau, J. A. Breier, and J. D. Kessler (2018). Using Carbon Isotope Fractionation to Constrain the Extent of Methane Dissolution Into the Water Column Surrounding a Natural Hydrocarbon Gas Seep in the Northern Gulf of Mexico. *Geochemistry, Geophysics, Geosystems*. 19, 4459–4475.

<https://doi.org/10.1029/2018GC007705>

Leonte, M., Ruppel, C. D., Ruiz-Angulo, A., and J. D. Kessler (2020). Surface methane concentrations along the Mid-Atlantic Bight driven by aerobic subsurface production rather than seafloor gas seeps. *Journal of Geophysical Research: Oceans*, 125, e2019JC015989. <https://doi.org/10.1029/2019JC015989>

Sparrow, K. J. and J. D. Kessler (2017). Efficient collection and preparation of methane from low concentration waters for natural abundance radiocarbon analysis. *Limnology & Oceanography: Methods*, 15(7),601-617. <https://doi.org/10.1002/lom3.10184>

Sparrow, K., J.D. Kessler, J.R. Southon, F. Garcia-Tigreros, K.M. Schreiner, C.D. Ruppel, J.B. Miller, S.J. Lehman, and X. Xu (2018). Limited contribution of ancient methane to surface waters of the U.S. Beaufort Sea, *Science Advances*, 4. <https://www.science.org/doi/10.1126/sciadv.aao4842>

Weinstein, A., L. Navarrete, C. Ruppel, T. C. Weber, M. Leonte, M. Y. Kellermann, E. C. Arrington, D. L. Valentine, M. I. Scranton, and J. D. Kessler (2016). Determining the flux of methane into Hudson Canyon at the edge of methane clathrate hydrate stability, *Geochem. Geophys. Geosyst.*, 17, 3882–3892, doi:[10.1002/2016GC006421](https://doi.org/10.1002/2016GC006421).

Juanes (MIT)/Weber (UNH)/ Ruppel & Waite (USGS) – Fate of methane emitted from dissociating marine hydrates: modeling, laboratory, and field constraints

Alizadeh Pahlavan, A. L. Cueto-Felgueroso, G. H. McKinley and R. Juanes (2015). Thin films in partial wetting: internal selection of contact-line dynamics. *Physical Review Letters*, 115, 034502, doi:10.1103/PhysRevLett.115.034502.

Cueto-Felgueroso, L. and R. Juanes (2014). A phase-field model of two-phase Hele-Shaw flow. *J. Fluid Mech.*, 758, 522-552, doi:10.1017/jfm.2014.512.

Fu, X. L. Cueto-Felgueroso, and R. Juanes (2016). Thermodynamic coarsening arrested by viscous fingering in partially-miscible binary mixtures. *Physical Review E*, 94, 033111 (2016), doi:10.1103/PhysRevE.94.033111.

Fu, X., Cueto-Felgueroso, L., & Juanes, R. (2018). Nonequilibrium thermodynamics of hydrate growth on a gas-liquid interface. *Physical Review Letters*, 120(14), 144501. <https://doi.org/10.1103/PhysRevLett.120.144501>

Fu, X., Jimenez-Martinez, J., Nguyen, T. P., Carey, J. W., Viswanathan, H., Cueto-Felgueroso, L., & Juanes, R. (2020). Crustal fingering facilitates free-gas methane migration through the hydrate stability zone. *Proceedings of the National Academy of Sciences of the United States of America*, 117(50), 31660– 31664.

Fu, X., Waite, W. F., Cueto-Felgueroso, L., & Juanes, R. (2019). Xenon hydrate as an analog of methane hydrate in geologic systems out of thermodynamic equilibrium. *Geochemistry, Geophysics, Geosystems*, 20, 2462– 2472. <https://doi.org/10.1029/2019GC008250>

Padilla, A. M., & Weber, T. C. (2021). Acoustic backscattering observations from non-spherical gas bubbles with ka between 0.03 and 4.4. *Journal of the Acoustical Society of America*, 149(4), 2504– 2519. <https://doi.org/10.1121/10.0004246>

Scandella, B. P., L. Pillsbury, T. Weber, C. Ruppel, H. F. Hemond, and R. Juanes (2016). Ephemerality of discrete methane vents in lake sediments, *Geophys. Res. Lett.*, 43, 4374–4381, doi:[10.1002/2016GL068668](https://doi.org/10.1002/2016GL068668).

Waite, W.F., T. Weber, X. Fu, R. Juanes, and C. Ruppel (2017). Laboratory observations of the evolution and rise rate of bubbles with and without hydrate shells, *Proc. 9th Int. Conf. on Gas Hydrates*, Denver, 14 pp.

Weber, T., Mayer, L., Jerram, K., Beaudoin, J., Rzhhanov, Y. and Lovalvo, D. (2014). Acoustic estimates of methane gas flux from the seabed in a 6000 km² region in the Northern Gulf of Mexico. *Geochemistry, Geophysics, Geosystems*. 15(5): 1911-1925 (2014), doi:[10.1002/2014GC005271](https://doi.org/10.1002/2014GC005271).

Hornbach (SMU), Colwell (OSU), Ruppel/Pohlman (USGS) – Gas hydrate dynamics on the US Continental Slope

Ruppel, C. D., Kluesner, J., Pohlman, J., Brothers, D., Colwell, F., Krause, S., and Treude, T. (2015). Methane Hydrate Dynamics on the Northern US Atlantic Margin, *Fire in the Ice*, DOE/National Energy Technology Lab Gas Hydrates Newsletter, 15(2), pp. 10-13, Winter 2015. https://www.netl.doe.gov/sites/default/files/publication/MHNews_2015_December.pdf#page=10

Hornbach, M. J., Harris, R. N., & Phrampus, B. J. (2020). Heat flow on the U.S. Beaufort Margin, Arctic Ocean: Implications for ocean warming, methane hydrate stability, and regional tectonics. *Geochemistry, Geophysics, Geosystems*, 21, e2020GC008933. <https://doi.org/10.1029/2020GC008933>

Phrampus, B., M. Hornbach, C. Ruppel, and P. Hart (2014). Widespread gas hydrate instability on the upper U.S. Beaufort margin, *J. Geophys. Res.*, 119, doi:[10.1002/2014JB011290](https://doi.org/10.1002/2014JB011290).

Pohlman, J., Ruppel, C.D., Colwell, F.S., Krause, S., Treude, T., Graw, M.F., Casso, M., Boze, L.-G., Buczkowski, B., and D. Brankovits (2015). Sediment and water column geochemistry related to methane seepage along the northern US Atlantic margin, AGU Fall Meeting, San Francisco, Dec. 14-18, 2015. OS33A-1992.

Prouty, N. G., D. Sahy, C. D. Ruppel, E. B. Roark, D. Condon, S. Brooke, S. W. Ross, and A. W. J. Demopoulos (2016). Insights into methane dynamics from analysis of authigenic carbonates and chemosynthetic mussels at newly-discovered Atlantic Margin seeps, *Earth Planet. Sci. Lett.*, 449, 332– 344, doi:[10.1016/j.epsl.2016.05.023](https://doi.org/10.1016/j.epsl.2016.05.023)

Wooller/Walter Anthony/Leigh (UAF), Ruppel/Pohlman (USGS) – Source characterization and temporal variation of methane seepage from thermokarst lakes on the Alaska North Slope in response to arctic climate change

Wooller, M. J., Ruppel, C., Pohlman, J. W., Leigh, M. B., Heintz, M. and Anthony, K. W. (2009). Permafrost Gas Hydrates and Climate Change: Lake-Based Seep Studies on the Alaskan North Slope, *Fire in the Ice*, DOE/National Energy Technology Lab Gas Hydrates Newsletter, 9(3), pp. 6-9, Summer 2009.

<https://www.netl.doe.gov/sites/default/files/publication/MHNewsSummer09.pdf#page=6>

Gaglioti, B. V., Mann, D. H., Jones, B. M., Pohlman, J. W., Kunz, M. L., and Wooller, M. J. (2014). Radiocarbon age-offsets in an arctic lake reveal the long-term response of permafrost carbon to climate change, *J. Geophys. Res. Biogeosci.*, 119, 1630– 1651, doi:[10.1002/2014JG002688](https://doi.org/10.1002/2014JG002688).

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, M. B. Leigh (2012a). Diversity of active aerobic methanotrophs along depth profiles of arctic and subarctic lake water column and sediments. *The ISME Journal*. doi:10.1038/ismej.2012.34

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, M. B. Leigh (2012b). Shifts in identity and activity of methanotrophs in arctic lake sediments in response to temperature changes. *Applied and Environmental Microbiology* 78(13):4715-4723.

He, R. M. J. Wooller, J. W. Pohlman, C. Catranis, J. Quensen, J. M. Tiedje, M. B. Leigh (2012c). Identification of functionally active aerobic methanotrophs in sediments from an arctic lake using stable isotope probing. *Environmental Microbiology* 14(6):1403-1419.

Isaksen, I. S. A., M. Gauss, G. Myhre, K. M. Walter Anthony, and C. Ruppel (2011). Strong atmospheric chemistry feedback to climate warming from Arctic methane emissions, *Global Biogeochem. Cycles*, 25, GB2002, doi:10.1029/2010GB003845

Walter Anthony, K. M., P. Anthony, G. Grosse, J. Chanton (2012). Geologic methane seeps along boundaries of arctic permafrost thaw and melting glaciers, *Nature Geoscience*, DOI doi:org/10.1038/Ngeo1480.

Walter Anthony, K. Vas, D., Brosius, L., Chapin, F. S. III, Zimov, S.A., and Zhuang, Q (2010). Estimating methane emissions from northern lakes using ice bubble surveys. *Limnol. Oceanogr.: Methods* 8, 2010, 592–609.

Wooller, M. J., Pohlman, J. W., Gaglioti, B. V., Langdon, P., Jones, M., Walter Anthony, K. M., Becker, K. W., Hinrichs, K. U., Elvert, M. (2012). Reconstruction of past methane availability in an Arctic Alaska wetland indicates climate influenced methane release during the past ~12,000 years. *Journal of Paleolimnology* DOI 10.1007/s10933-012-9591-8.

Wooller, MJ, Pohlman, JW, Gaglioti, BV, Langdon, P, Jones, M, Walter Anthony, KM, Becker, KW, Hinrichs, KU and Elvert, M (2012). Reconstruction of past methane availability in an Arctic Alaska wetland indicates climate influenced methane release during the past ~12,000 years. *Journal of Paleolimnology*, 48(1). 27-42. [doi:10.1007/s10933-012-9591-8](https://doi.org/10.1007/s10933-012-9591-8)