GPHY 891 Special Topics
(3 credits; Tuesdays 11:30-14:00)

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Prerequisite: none

Content and learning outcomes:

This course focuses on advanced topics in micrometeorology. No previous specific knowledge of micrometeorology is required although the course assumes more than a passing acquaintance with scientific methods. The first part of the course will (re-) introduce the fundamental processes related to the study of energy and gas exchange. Then, through more advanced readings, we will explore contemporary methods and issues facing micrometeorologists in research environments. The focus will be on real world examples from natural, managed and modified ecosystems. Assessment is the production of a paper which surveys the literature in the intended area of research of the graduate student.

A selection of themes are proposed to be covered within the meetings:

1. Transfer of heat, momentum and gases in the surface boundary layer
2. The eddy covariance method for flux measurement
3. Perturbed ecosystems
4. Wetlands
5. Other themes as per student interest

Method: One 2.5 hour discussion period per week.

Textbook: None. Readings will be drawn from several texts and academic literature sources. See list below.

Graduate student paper: a paper that is associated with his/her thesis topic as it applies to micrometeorology. It is my intent that this may serve as part of the literature review chapter of the student's thesis.

Paper: 100%

Policy on lateness: The paper is due at the end of the term – date to be determined by mutual discussion.

Delivery: In person lectures/discussions and a 'hands-on' component in the AER Lab in Mac-Corry.

Useful Textbook Chapters for the Theory:

Arya, S.P., 1988. Introduction to Micrometeorology (First Edition). Academic Press.
- Chapter 5: Air Temperature and Humidity in the PBL
- Chapter 8: Fundamentals of Turbulence
- Chapter 11: Momentum and Heat Exchanges with Homogenous Surfaces

Bonan, G., 2008. Ecological Climatology. Second Edition, Cambridge.
- Chapter 13: Surface Energy Fluxes
- Chapter 14: Turbulent Fluxes
- Chapter 18: Plant Canopies
- Chapter 21: Ecosystems

Campbell, G.S. and Norman, J.M., 1998. An Introduction to Environmental Biophysics. 2 Ed., Springer.
- Chapter 5: Wind pp.63-76
- Chapter 10: Radiation Basics pp.147-165

Bailey, W.G., Oke, T.R., Rouse, W.R., 1997. The Surface Climates of Canada, McGill-Queen's Press.
- Chapter 1: Canada's Climate: An Overall Perspective
- Chapter 2: Surface Climate Processes
- Chapter 3: Spatial Variability in Surface Climates

Some useful starting points for scientific journal articles (lots of others out there):

Amiro, B.D., Barr, A.G., Black, T.A., Iwashita, H., Kljun, N., McCaughey, J.H., Morgenstern, K., Murayama, S., Nesic, Z., Orchansky, A.L., and Saigusa, N., 2006. Carbon, energy and water fluxes at mature and disturbed forest sites, Saskatchewan, Canada. *Agricultural and Forest Meteorology*, 136:237-251.

Amiro, B.D., 2010. Estimating annual carbon dioxide eddy fluxes using open-path analysers for cold forest sites. *Agricultural and Forest Meteorology*, 150: 1366–1372

Baldocchi. D.D., 2003. Assessing the eddy covariance technique for evaluating carbon dioxide exchange rates of ecosystems: past, present and future. *Global Change Biology*, 9: 479-492.

Barr, A.G., Black, T.A., Hogg, E.H., Griffis, T.J., Morgenstern, K., Kljun, N., Theede, A., and Nesic, Z., 2007. Climatic controls on the carbon and water balances of a boreal aspen forest, 1994-2003. *Global Change Biology*, 13: 561-576.

Dabberdt, W.F., Lenschow, D.H., Horst, T.W., Zimmerman, P.R., Oncley, S.P., and Delany, A.C., 1993. Atmosphere-surface exchange measurements. *Science*, 260: 1472-1481.

Falge, E., et al. (+33 authors!!), 2001. Gap filling strategies for defensible annual sums of net ecosystem exchange. *Agricultural and Forest Meteorology*, 107:43-69.

Grace, J., Nichol, C., Disney, M., Lewis, P., Quaife, T., and Bowyer, P., 2007. Can we measure terrestrial photosynthesis from space directly, using spectral reflectance and fluorescence? *Global Change Biology*, 13:1484-1497.

Humphreys, E.R., Black, T.A., Morgenstern, K., Cai, T., Drewitt, G.B., Nesic , Z., Trofymow, J.A., 2006. Carbon dioxide fluxes in coastal Douglas-fir stands at different stages of development after clearcut harvesting. *Agricultural and Forest Meteorology*, 140: 6–22.

Lafleur, P.M., Roulet, N.T., Bubier,J.L., Frolking, S., and Moore, T.R., 2003. Interannual variability in the peatland-atmosphere carbon dioxide exchange at an ombrotrophic bog. *Global Biogeochemical Cycles*, 17(2), 1036, doi:10.1029/2002GB001983.

Lafleur, P.M., and Humphreys, E.R., 2007. Spring warming and carbon dioxide exchange over low Arctic tundra in central Canada. *Global Change Biology* 14: 740–756.

Kim, J., Guo, Q., Baldocchi, D.D., Leclerc, M.Y., Xu, L., and Schmid, H.P., 2006. Upscaling fluxes from tower to landscape: Overlaying flux footprints on high-resolution (IKONOS) images of vegetation cover. *Agricultural and Forest Meteorology*, 136:132-146.

Nugent, K.A., Strachan, I.B., Strack, M., Roulet, N.T. and Rochefort, L., 2018. Multi-year net ecosystem carbon balance of a restored peatland reveals a return to carbon sink. *Global Change Biol.* 24(12): 5751-5768. doi:10.1111/gcb.14449

Oliphant, A.J., Grimmond, C.S.B., Zutter, H.N. Schmid, H.P., Su, H.-B., Scott, H.-B., Offerle, B., Randolph, J.C., and Ehman, J., 2004. Heat storage and energy balance fluxes for a temperate deciduous forest. *Agricultural and Forest Meteorology*, 126:185-201.

Pelletier, L., Moore, T.R., Roulet, N.T., Garneau, M., and Beaulieu-Audy, V., 2007. Methane fluxes from three peatlands in the La Grande Riviere watershed, James Bay lowland, Canada. *Journal of Geophysical Research*, 112, G01018, doi:10.1029/2006JG000216.

Rankin, T., Strachan, I.B. and Strack, M., 2018. Carbon dioxide and methane exchange at a post-extraction, unrestored peatland. *Ecological Engineering* 122: 241-251. doi:10.1016/j.ecoleng.2018.06.021

Soegaard, H., Jensen, N.O., Boegh, E., Hasager, C.B., Schelde, K., Thomsen, A., 2003. Carbon dioxide exchange over agricultural landscape using eddy correlation and footprint modeling. *Agricultural and Forest Meteorology* 114: 153–173.

Strachan, I.B., Tremblay, A., Pelletier, L., Tardif, S., Turpin, C. and Nugent, K.A., 2016. Does the creation of a Boreal hydroelectric reservoir result in a net change in evaporation? *Journal of Hydrology* 540: 886-899.

Strachan, I.B., Pelletier, L. and Bonneville, M-C., 2016. Interannual variability in water table level controls net ecosystem carbon dioxide exchange in a boreal bog. *Biogeochemistry* 127: 99-111.

Strack, M., Cagampan, J., Hassanpour Fard, G., Keith, A.M., Nugent, K.A., Rankin, T., Robinson, C., Strachan, I.B., Waddington, J.M., and Xu, B., 2016. Controls on plot-scale growing season CO_2 and CH_4 fluxes in restored peatlands: Do they differ from unrestored and natural sites? *Mires and Peat* 17(5): 1-18. doi: 10.19189/MaP.2015.OMB.216

Wilson, K., et al. (+20 authors!), 2002. Energy balance closure at FLUXNET sites. *Agricultural and Forest Meteorology*, 113:223-243.

Academic Integrity

Queen's students, faculty, administrators and staff all have responsibilities for upholding the fundamental values of academic integrity; honesty, trust, fairness, respect, responsibility and courage. These values are central to the building, nurturing, and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1), on the Arts and Science website, and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, use of forged materials, contract cheating, unauthorized use of intellectual property, unauthorized collaboration, failure to abide by academic rules, departure from the core values of academic integrity, and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions appropriate to the severity of the departure that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.