Regional-Scale Carbon Dioxide Fluxes During the 2007 Growing Season Derived from Simultaneous Radon-222 and Carbon Dioxide Measurements in Oklahoma

A.I. Hirsch[1], M.L. Fischer[2], S.C. Biraud[2], W.J. Riley[2], M.S. Torn[2], J.A. Berry[3], A.E. Andrews[4], S. Chambers[5], and W. Zahorowski[5]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder 80309; 303-497-6999, Fax: 303-497-5590, E-mail: Adam.Hirsch@noaa.gov
[2]Lawrence Berkeley National Laboratory, Berkeley, CA, 94720
[3]Department of Global Ecology, Carnegie Institution of Washington, Stanford, CA 94305
[4]NOAA Earth System Research Laboratory, Boulder, CO 80305
[5]Australian Nuclear Science and Technology Organisation, Menai, NSW, Australia

Radon is a useful tracer of transport processes in the lower atmosphere. It is emitted ubiquitously from soils, it is chemically inert, and decays with a half life of 3.8 days. Radon concentrations in the planetary boundary layer have been used in conjunction with collocated carbon dioxide measurements to estimate regional carbon dioxide surface fluxes. This approach relies on the knowledge of regional radon fluxes. Direct flux measurements are rare and the flux is known to vary over small spatial and temporal scales as a function of soil water content and soil uranium content. No well tested continent-scale emissions maps exist for North America. However, continent-scale maps do exist of the factors thought to control soil radon emissions such as those mentioned above. Using a continuous time series of radon from the ARM-CART SGP facility in Oklahoma and the transport model FLEXPART, as well as soil water and uranium content data, we infer a dependence of radon emissions on these two variables (Figure 1). The radon fluxes calculated using the inferred relationships are evaluated using an independent atmospheric radon time series 400 miles south in Texas. We then apply the so-called "radon tracer" method to solve for monthly-mean regional-scale carbon dioxide fluxes from March-September 2007 using daily afternoon average boundary-layer radon and carbon dioxide measurements. By combining daily radon flux estimates into monthly averages, we achieve a high precision on the resulting carbon dioxide fluxes, though we cannot rule out biases caused by the transport model used to help estimate our radon fluxes.

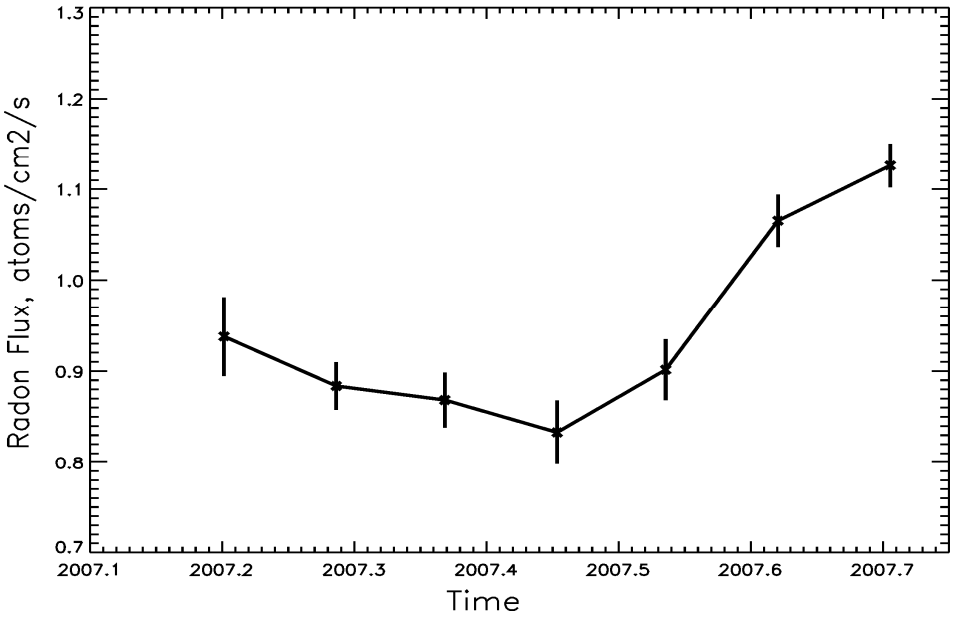

Figure 1. Monthly average radon-222 flux upwind of the ARM-CART SGP 60-m tower inferred from atmospheric radon measurements and datasets of soil ^{238}U (from USGS) and soil moisture (from NASA). Error bars represent the standard error of the daily radon flux estimates within a given month.