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Radon Measurements of Atmospheric Mixing (RAMIX) 2006–2014

Final Campaign Summary

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May 2015

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Summary

Uncertainty in vertical mixing between the surface layer, boundary layer, and free troposphere leads to large uncertainty in "top-down" estimates of regional land–atmosphere carbon exchange (i.e., estimates based on measurements of atmospheric CO_2 mixing ratios). The radioisotope radon-222 (^{222}Rn) is a valuable tracer for measuring atmospheric mixing because it is emitted from the land surface and has a short enough half-life (3.8 days) to allow characterization of mixing processes based on vertical profile measurements.

The Radon Measurements of Atmospheric Mixing Field Campaign was a collaborative effort between the National Oceanic and Atmospheric Administration Climate Monitoring and Diagnostics Laboratory (A Hirsch) and Lawrence Berkeley National Laboratory (ML Fischer and SC Biraud). During the campaign from 2006 through 2014, we measured atmospheric ^{222}Rn concentrations from the 60-m tower at the Southern Great Plains facility with the objectives of 1) estimating the time-averaged atmospheric mixing between the different atmospheric layers and 2) using the measured mixing rates to estimate regional CO_2 exchange.

Acronyms and Abbreviations

^{222}Rn	Radon-222 radioisotope
CLASIC	Cloud and Land Surface Interaction Campaign
LBNL	Lawrence Berkeley National Laboratory
NOAA	National Oceanic and Atmospheric Administration
RAMIX	Radon Measurements of Atmospheric Mixing

Contents

1.0 Background

Uncertainty in vertical mixing between the surface layer, boundary layer, and free troposphere leads to large uncertainty in "top-down" estimates of regional land-atmosphere carbon exchange (i.e., estimates based on measurements of atmospheric CO_2 mixing ratios. Radon-222 (^{222}Rn) is a valuable tracer for measuring atmospheric mixing because it is emitted from the land surface and has a short enough half-life (3.8 days) to allow characterization of mixing processes based on vertical profile measurements.

The objectives of the Radon Measurement of Atmospheric Mixing (RAMIX) Field Campaign were to 1) estimate the time-averaged atmospheric mixing between the different atmospheric layers and 2) use the measured mixing rates to estimate regional CO_2 exchange. An additional motivation for the RAMIX campaign was to identify the source of air masses that have were influenced by land surface CO_2, water, and energy fluxes.

During the campaign, ^{222}Rn was measured with a continuous flow-through system located at the base of the 60-m tower at the Atmospheric Radiation Measurement (ARM) Southern Great Plains Central Facility. The system inlet was located at the top of the tower at 60 m. The campaign was a collaborative effort between Lawrence Berkeley National Laboratory (LBNL) and the National Oceanic and Atmospheric Administration (NOAA). The instrument was provided by NOAA in a campaign initiated by Adam Hirsch (NOAA) and Marc Fischer (LBNL), and later managed by Fischer.

As background on radon, the ^{222}Rn concentration is given as a radioactive activity with units of Becquerels per cubic meter (Bq/m3). This value corresponds to the number of ^{222}Rn radioactive decays per cubic meter of air per second. One Bq of ^{222}Rn corresponds to approximately 0.5 atoms per cubic centimeter, using a half-life value of 3.825 days.

2.0 Notable Events or Highlights

Airborne ^{222}Rn data were first collected during the Cloud and Land Surface Interaction Campaign (CLASIC) in 2007.

3.0 Lessons Learned

The application of radon measurements to evaluating atmospheric transport was limited by the lack of data on spatial and temporal variations in soil radon emissions for the continental United States.

4.0 Results

During CLASIC, ^{222}Rn data showed that the land surface was inundated over much of the domain, so almost no ^{222}Rn was transported from the soil and into the atmosphere.

RAMIX data have been archived for the 2006 to 2008 campaign, and data for the 2009 to 2010 campaign have been submitted for archiving.

5.0 Public Outreach

None

6.0 Publications

None

7.0 References

Kritz, MA, SW Rosner, and DZ Stockwell. 2012. "Validation of an off-line three-dimensional chemical transport model using observed radon profiles 1. Observations." *Journal of Geophysical Research, Atmospheres* 103(D7), 8425−8432, doi:10.1029/97JD02655.

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