Annotated Bibliography: Chamber-based measurement systems for CO2 efflux

Butnor, Johnsen, Maier (2005)

**Keywords: CO2 efflux, Porosity, Soil CO2 efflux, Soil Respiration, Open systems, Closed systems**

*Title:* Soil properties differently influence estimates of soil CO2 efflux from three chamber-based measurement systems

*Introduction (Butnor, 2005):* In determining the productivity of an ecosystem, CO2 efflux is important. Measuring the efflux is difficult and there are many approaches and different technologies to determine this CO2 efflux. Eddy Covariance is one way, but chambers are more direct in determining CO2 efflux. There isn’t much information on whether a closed or open chamber are more effective, some studies even have contradicting results. This study compares three systems in the lab and field. The systems include two closed chambers and one open chamber. The comparisons were made based on how well the trends in the field related to the controlled environment of the lab setting.

*Methods (Butnor, 2005):*

Li-Cor soil CO2 flux chamber (Li-6400): The Li-6400 is a closed system that measures an area of 71.6 cm2. The CO2 concentration in the head is pulled below the ambient concentration and then the CO2 is measured as it accumulates in the chamber. The efflux is then determined from the CO2 concentrations. The con of using the Li-6400 is the sensitivity of the delta CO2 settings.

PP systems SRC-1 soil respiration chamber: The SRC-1 is a closed system that measures an area of 78.5 cm2. A fan clears the chamber contents and fills the chamber with ambient CO2 concentrations. Measurements are taken by the environmental gas monitor connected to the soil respiration chamber. The con is that the fan speed cannot be controlled.

Automated carbon efflux system: The automated carbon efflux system is an open system that measures from 15 soil chambers equaling an area of 491 cm2. All 15 chambers and the 1 null are measured sequentially using reference air as a refresher. The con is that it requires a correction equation for resistance to diffusion when CO2 builds up.

Laboratory Experiment: An artificial efflux apparatus was created. The measurements were gathered through various mediums that had differing CO2 diffusion coefficients. A data logger collected the CO2 efflux from the surface at real time and maintained a certain rate by adding CO2 when needed. Each system was tested in the way that would be normal in the field. The ACES was left for continuous monitoring where as the other two were lifted after the measurement was taken.

Field Experiment: Each of the three instruments were used to test CO2 efflux at four different sites. Two still contained litter cover and the other two were cleared from the litter. Three of the sites were forests of loblolly pines of various ages. The soil at each site was analyzed for physical properties including composition, BD, porosity, moisture content, and air-filled porosity. Since each system tested different areas, the Li-Cor and SRC-1 was measured 15 times at each site. The sample locations were within 20 cm apart.

*Results (Butnor, 2005):*

Laboratory Experiment: The ACES was close to the expected on all types of media. The Li-6400 underestimated the fluxes for the porous medium and the SRC-1 was quite variable for all mediums compared to the other two.

Field Experiment: The Li-6400 and ACESadj. Were similar are most of the sites where as the SRC-1 was quite variable compared to the other two and across sites. The two sites that contained intact litter had high variability between the Li-6400 and the ACESadj than the other two.

Integrating laboratory and field experiments: Soil-air volume did not have an effect on the ACES technique and since the AcESadj was closest in the lab with all mediums, it was assumed to be the closest measurement in the field. The other two systems tended to underestimate when the soil/medium increased in porosity. Therefore, the two closed systems do have issues with the soil-air ratio to volume. An equation can be used to compensate for this underestimated but this doesn’t always work and was only effective for some of the Li-6400, the SRC-1 was much more variable.

*Discussion (Butnor, 2005):* The ACES open system was the most accurate or closest to the expected out of the three instruments and therefore would need the smallest sample size. The Li-Cor closed system was fairly close to the model estimate leading researchers to think that the only problem is that it is a closed system. Closed systems have a tendency to underestimate CO2 efflux because of the porosity or soil-air volume. The ACES can adjust for SRC-1 showed the most variation and showed more problems with the results than just the fact that it is a closed system. The closed systems are cheaper, portable, and make faster measurements. There are problems with both systems which makes reliable C budget estimates difficult to achieve.