P1.15 PRESSURE PUMPING EFFECTS ON SOIL EFFLUX MEASUREMENTS OF CO_2

Alan J. Ideris*
University of California, Davis, California
and
Kyaw Tha Paw U
University of California, Davis, California

1. INTRODUCTION

Climate change models predict relatively large air temperature increases in the next century, caused by green house gases such as CO_2. These concentrations of CO_2 are continuing to rise annually and fossil fuel emissions are a major source of the atmospheric CO_2, Although the North American terrestrial ecosystems are estimated to be a major sink of carbon (one to two Pg carbon per year, see Pacala et al., 2001), agricultural soils are significant sources of CO_2 efflux back into the atmosphere. Therefore the measurement and modeling of soil CO_2 efflux is an important component in understanding the role of terrestrial ecosystems in sequestering carbon. Understanding soil carbon pools and processes require accurate measurements of soil CO_2 efflux; however, if pressure pumping is important, many measurement techniques such as soil chambers may need to be modified to account for such pumping.

CO_2 efflux from soils may be significantly modulated by turbulent and lower frequency pressure fluctuations (Auer et al., 1996; Massman et al., 1997), although there are some reports that this term may have a small influence on the isotopic ratio of the oxygen component of CO_2 (Stern et al., 1999). This has implications both in terms of a basic understanding of CO_2 efflux and the measurement of CO_2 exchange.

2. METHODS

Experiments are being carried out in an agricultural transect used for growing maize (corn). In our study, we measured the barometric pressure at 10 Hz at the soil surface, by use of fast response pressure transducers (Omega Engineering, Inc., Model PX2670). Measurements began in the fall of 2003, over bare soil, and continued through planting and growth of maize. Fast response data were logged on laptop computers with dataloggers attached. A three-dimensional ultrasonic anemometer (Campbell Scientific Inc. CSAT-3) was placed approximately 1 m above the soil surface to measure the velocity and temperature at 10 Hz. The efflux of CO_2 from the soil was measured by direct eddy-covariance by use of a fast response Licor-7500 open path CO_2 sensor.

The experimental data is being examined for the effects of turbulence on pressure perturbations at the surface and the indicated depths. We report on preliminary biomicrometeorological measurements which in the future will be used to establish a possible relationship between pressure perturbations and soil CO_2 efflux from the total net ecosystem exchange. Statistical analysis of the standard deviation, skew, and kurtosis of the turbulence and pressure signal are being examined as well as the effects of these parameters on the theoretical equations.

3. RESULTS

Cross-comparison of pressure sensors with their sample ports situated at the surface shows good correspondence, with some offsets occurring (Figure 1). High frequency responses appear equivalent. The next step will be to place the sample ports at several depths to examine pressure attenuation with depth.

Carbon dioxide fluxes in the spring of 2004 after some weed growth shows some photosynthetic activity in the day, and respiration at night, as expected (Figure 2). Nocturnal respiration appears in the range reported in the literature, 2-10 μmol m^{-2} s^{-1}, and photosynthesis is of lower magnitude, approximately -1 to -5 μmol m^{-2} s^{-1}.

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* *Corresponding author address*: Alan J. Ideris, Univ. of California, Department of Land, Air, and Water Resources, Davis, CA 95616; email: ajideris@ucdavis.edu

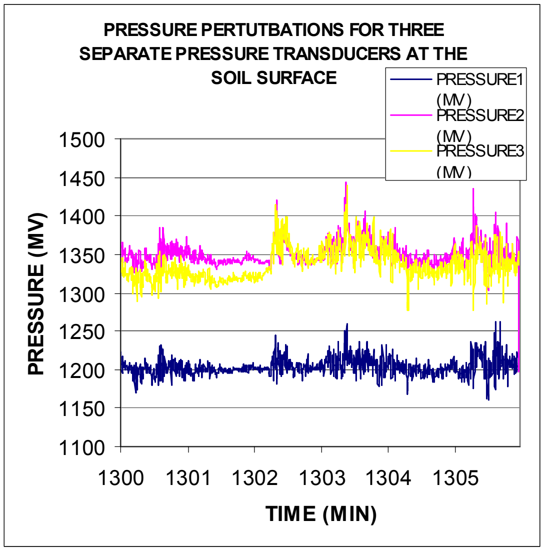

Figure 1. Pressure perturbations at the soil surface for three pressure transducers over a period of six minutes. Measurements are outputted in millivolts.

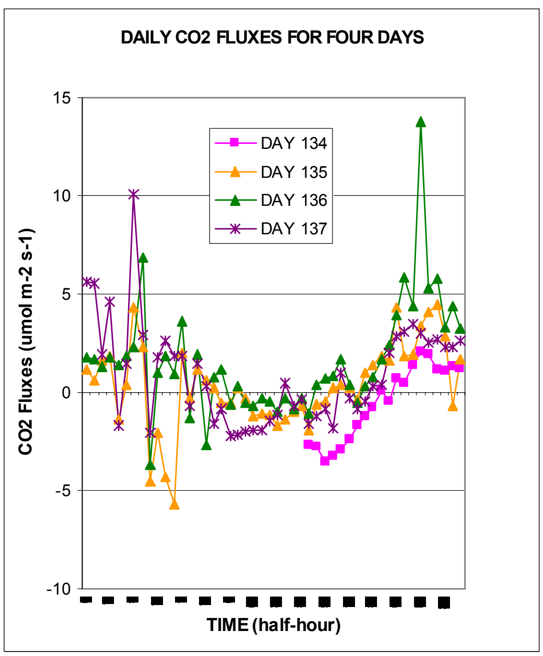

Figure 2. Carbon dioxide fluxes in agricultural maize transect for four consecutive days measured in micromoles per meters squared per second.

4. ACKNOWLEDGEMENTS

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