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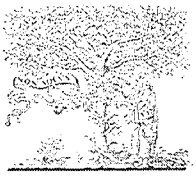

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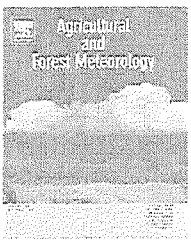

Carbon dioxide exchange in a subtropical, mixed C_3/C_4 grassland on the Edwards Plateau, Texas

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ABSTRACT

Eddy covariance measurements were begun in late April 2004 to quantify CO_2 exchange in a perennial C_3/C_4 grassland on the Edwards Plateau near San Marcos, TX. Objectives were to document how net ecosystem exchange of CO_2 (NEE) and its components, gross photosynthesis (GPP) and ecosystem respiration (R_e), vary on a seasonal and interannual basis, and to examine how environmental factors affect C exchange. Described here are the first 32 months of measurements. The grassland was intermittently grazed in 2004 and 2005, and heavily grazed during the spring and summer of 2006. Total rainfall from May through December 2004 was 1378 mm, well above the 858 mm annual mean, whereas rainfall in 2005 and 2006 was near normal. The grassland was dominated by C_4 grasses when measurements began, but C_3 grasses and forbs became dominant as the study progressed. The shift from a C_4- to a C_3-dominated ecosystem was accompanied by a 24% decline in light use efficiency. Water deficits were a frequent occurrence, even during 2004 when rainfall was high, causing large reductions in R_e, GPP, and light use efficiency, and temporary shifts in the grassland from C sink to C source. Our measurements showed the grassland was a small C sink over the 32 months, gaining 170 g m^{-2} of C, due in large part to drought-induced suppression of R_e during the winter of 2005–2006, and to a pulse of growth that occurred during the last 3 months of 2006. Total GPP and R_e were 2081 and 1911 g m^{-2}, respectively. The grassland accumulated 1037 g m^{-2} of C during the daytime, and lost 867 g m^{-2} at night. Rates of C uptake were highest in the spring, and were higher when grazing was heaviest because growth of new leaves having a high photosynthetic efficiency, and reductions in R_e, compensated for loss of leaf area.

1. Introduction

Most studies of CO_2 exchange in terrestrial ecosystems have focused on forests because of their potential to sequester large amounts of atmospheric CO_2 (Pacala et al., 2001). Less attention had been paid to CO_2 exchange in grasslands, in spite of the fact that they occupy approximately the same area extent as forests, because grasslands are perceived to be carbon neutral (Jaksic et al., 2006). There is evidence, however, that grasslands can be significant sources or sinks of atmospheric CO_2 (Novick et al., 2004), depending on rainfall (Knapp et al., 2002), management (Verburg et al., 2004), and the impact of disturbances such as grazing and fire (Derner et al., 2006).

A literature summary by Novick et al. (2004) found annual sums of net ecosystem C exchange (NEE) in grasslands ranging

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