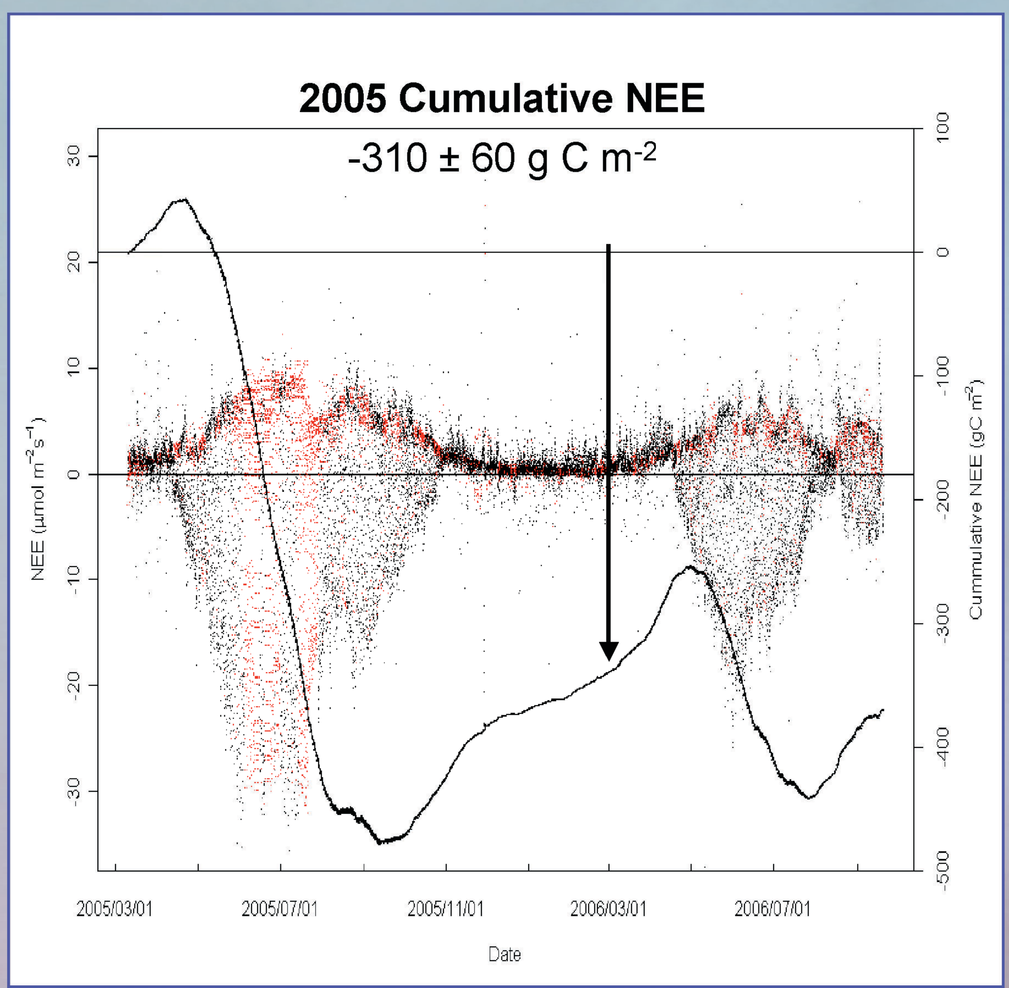
Effects of Burning and Drought on Carbon Exchange in Tallgrass Prairie at El Reno, OK

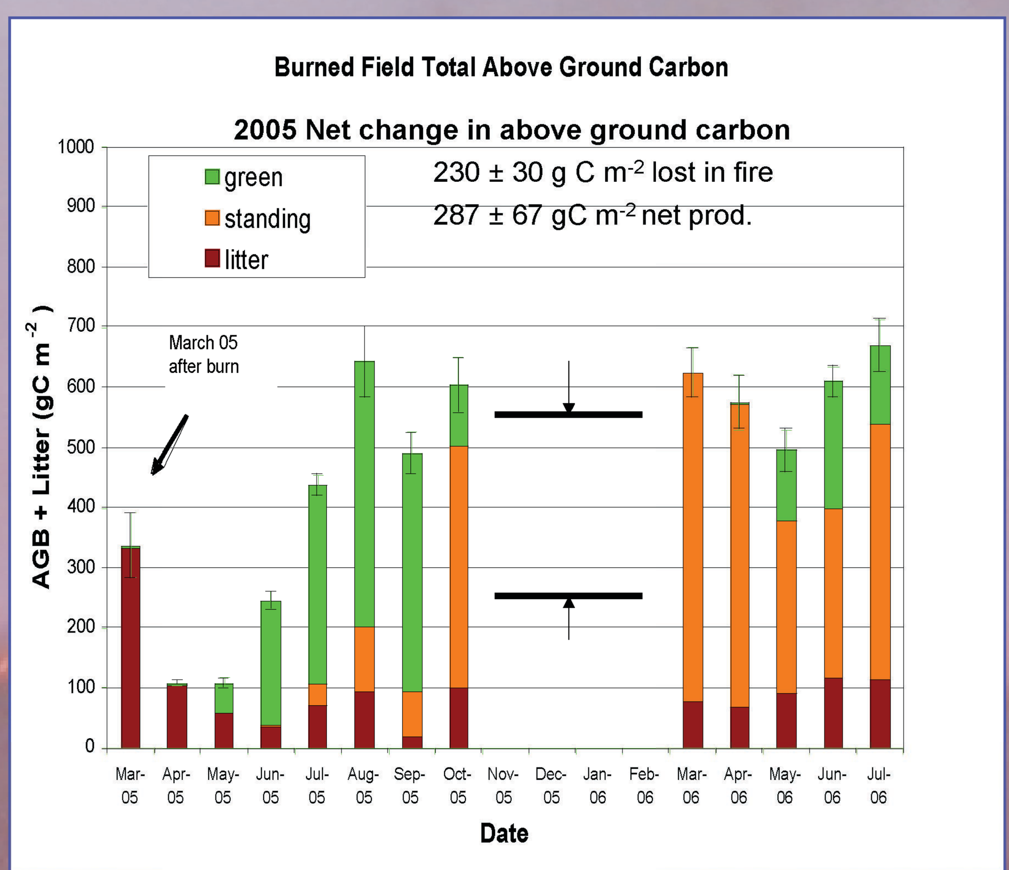
Marc L. Fischer[1], David P. Billesbach[2], Margaret S. Torn[1], Brian Northup[3], Geoff Doyle[4], and Patrick Dowell[5]

Abstract: Prescribed burns are a common management tool applied to native rangelands in the Southern Great Plains ARM Climate Research Facility, with large and mixed effects on radiative balance and biogeochemical cycles. We initiated a two-year study in March 2005 at the USDA-ARS Grazinglands Research Laboratory, El Reno, OK, to describe how a prescribed spring burn might affect the carbon, water, and energy cycles of a tallgrass prairie. For this purpose, we selected two adjacent 33 ha pastures with identical and low intensity grazing and burning histories. Before burning one field, sampled soil carbon and vegetation by functional groups in both fields. After burning one field, we installed portable eddy flux systems, and CO_2 soil respiration systems. The burned field produced substantially more biomass during the 2005 growing season, and had nearly compensated for the carbon lost during the burn. Comparison of above ground production and net ecosystem exchange suggests that similar and only modest amounts of carbon were likely stored below ground. A strong drought occurred in 2006 (affecting the entire SGP region), which significantly reduced biomass production, carbon exchange, and latent heat flux relative to 2005, and increased fluxes of sensible heat. Little effect of the 2005 burning treatment was observed in any of the micrometeorological variables during 2006. Ongoing analysis will examine whether changes in above and below ground carbon stocks can be detected over the two-year period of this study

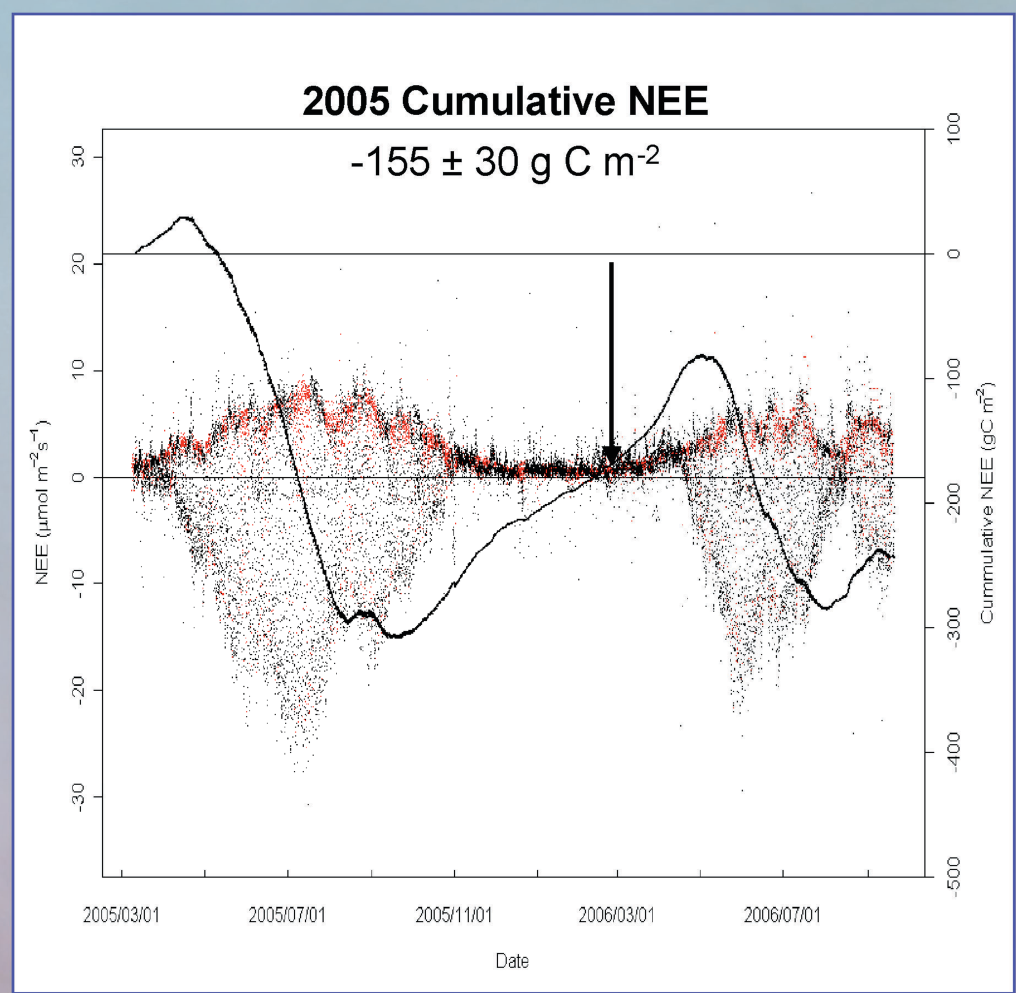
Measured Changes in Net Carbon Exchange (NEE) and Above Ground Biomass (AGB)

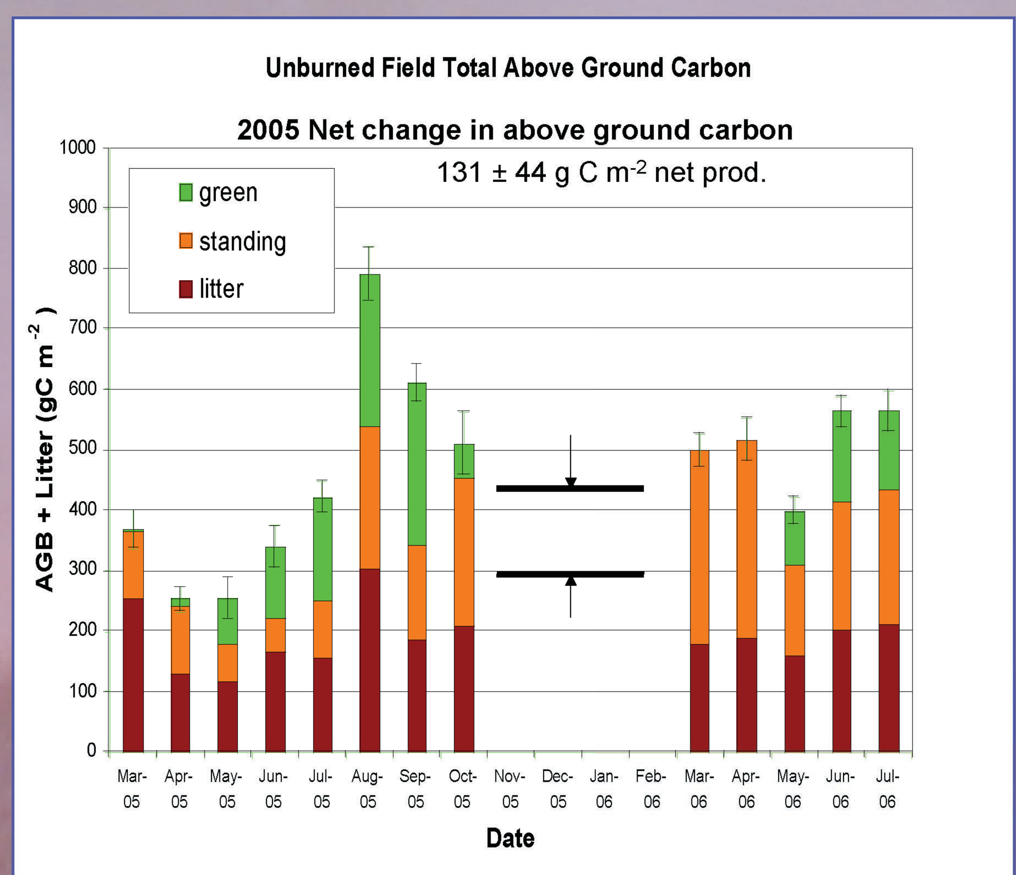
Burned Pasture





Unburned Pasture





Above Ground Constraint on Change in Below Ground Carbon

Here we explore whether it is possible to constrain changes in below ground carbon from the difference in measured changes in NEE and AGB. Here we construct the mass balance for net carbon exchange

$$-\Delta NEE = -\int NEE dt = \Delta C_{tot} = \Delta AGB + \Delta Litter + \Delta SOM + \Delta Root$$

where _AGB, _Litter, _SOM, and _Root are the changes in carbon stocks of AGB, litter, soil organic matter, and root biomass respectively. This assumes there are no other flows of carbon to or from the system (e.g., leaching, erosion).

The change in below ground carbon inferred from first year of the experiment is then:

$-\Delta NEE - (\Delta AGB + \Delta Litter) =$

$310 \pm 60 - (287 \pm 67) = 23 \pm 90$ g C m^{-2} (burned)

$155 \pm 30 - (131 \pm 42) = 24 \pm 51$ g C m^{-2} (unburned)

Change in one year is not detectable given measurement uncertainty

Summary

- After accounting for loss of carbon during fire, net carbon gain in the burned field (80+/- 90 g C m^{-2}) was lower than in unburned field (150 +/- 30 g C m^{-2}). **This contrasts with results of significant net uptake following fire in previous studies of other grasslands.**
- Comparison of cumulative annual NEE and AGB suggests little belowground storage of carbon in the first year of the study.
- Drought stress in 2006 reduced plant production by approximately a factor of two relative to 2005.

[1]Lawrence Berkeley National Laboratory, Berkeley, CA (mlfischer@lbl.gov)
[2]University of Nebraska-Lincoln, Lincoln, NE
[3]USDA-ARS Grazinglands Research Laboratory, El Reno, OK
[4]SAI Corp. Aberdeen Proving Ground, MD
[5]US DOE ARM, Southern Great Plains CRF, Billings, OK

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