

Title: Soil CO₂ flux from plots with various fire histories at the Konza Prairie Biological Station

Associated publication: Slette, I.J., Liebert, A. & Knapp, A.K. Fire history as a key determinant of grassland soil CO₂ flux. *Plant Soil* **460**, 579–592 (2021). <https://doi.org/10.1007/s11104-020-04781-0>

Abstract: There is abundant evidence that ongoing changes to fire regimes are affecting the global carbon cycle. However, uncertainty about how the response to an individual fire may be affected by historical factors such as the time elapsed since the last fire or the long-term fire frequency makes it difficult to predict the effects of changing fire regimes on carbon cycling. We took advantage of a 35-year fire frequency experiment (annual fire, fire every two or four years, and unburned treatments) in a native, mesic grassland to assess how fire history (time since last fire and long-term frequency) affects soil CO₂ flux, a key ecosystem carbon output. We found that historic fire frequency altered the magnitude of the response to fire, with greater post-fire soil CO₂ flux stimulation in annually burned grassland than in grassland burned every two or four years. Fire-induced flux increases persisted for two years after fire in grassland burned every four years. Though we found that fire also stimulated aboveground net primary productivity (ANPP), a key ecosystem carbon input, this stimulation was not altered by long-term fire frequency and didn't persist into later years, unlike soil CO₂ flux. This asymmetry emphasizes the importance of measuring impacts both aboveground and belowground. Our findings demonstrate that fire history modifies a key response to individual fires in this grassland. To understand and predict the dynamics of important global carbon cycle components, it is necessary to consider not only the presence vs. absence of fire, but also the long-term fire regime.

Contact: Ingrid Slette (ingrid.slette@colostate.edu)

Recommended dataset citation: Slette, I. J., Liebert, A., Knapp, A.K. (2020). Soil CO₂ flux from plots with various fire histories at the Konza Prairie Biological Station. Colorado State University. Libraries. <https://doi.org/10.25675/10217/203620>

Data collection location: Konza Prairie Biological Station

Data collection time period: 2016-06-06 to 2017-05-26

File information: 2 files are included in this folder.

1. "Soil CO₂ flux from plots with various fire histories at the Konza Prairie Biological Station"

This is the finalized dataset on which the submitted publication by Slette, I.J., Liebert, A., & Knapp, A.K. is based.

File format: .csv

2. "README". Contains detailed information concerning file 1.

File format: .pdf

Variable information: (column headings in dataset)

Date: date (MM/DD/YY) of measurement collection. Range: 06/06/16 – 05/26/17

Plot: number of plot where measurement was collected. Range: 0-15

Fire_frequency: long-term fire frequency. Values: annual, 2-year, 4-year, unburned

Years_since_fire: the number of years elapsed since the last fire. Range: 0-3, 35

Collar: refers to one of the two or four collars for measuring soil CO₂ flux that were installed in each plot. Range: a-d

Community: the dominant vegetation type of the community in which the measurement was collected. Values: grassy, woody

Soil_co2_flux: the values of the soil CO₂ flux measurement that was collected. Missing values: blank cell. Units: $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$

Methods:

Study Site: Research was conducted at the Konza Prairie Biological Station (KPBS) in NE Kansas, USA. Recurring fires are a historical feature of this grassland and are key for its existence and for reducing woody plant encroachment (Briggs et al., 2005; Knapp et al., 1998a). The climate is temperate mid-continental with cold, dry winters and warm, wet summers. The mean annual temperature is 13°C (Knapp et al., 1998a), and the mean annual precipitation is 851mm, almost 70% of which occurs during the growing season. The study took place in a lowland site with deep soils classified as Typic Argiustoll, with a silty clay loam texture (8% sand, 32% clay), and a bulk density of 1.5 g m⁻³ (Blecker, 2005).

Study Design: The KPBS is a U.S. Long-Term Ecological Research (LTER) site and this study took place in plots established in 1981 to evaluate the effects of different fire regimes on tallgrass prairie. Experimental plots (10m x 25m) have been burned in the spring (mid-March) at one-, two-, or four-year intervals, or left unburned since their establishment. The study includes annually burned plots first burned in 1981, two-year treatments initiated in 1981 and in 1982, and four-year treatments started in 1981-1984. This design results in plots in each year of a two-year and a four-year fire cycle available for sampling each year. The experiment includes two replicate plots of each fire frequency x years since last fire treatment combination. At the time of our study, the annual fire plots that we sampled had been burned 36 times, the two-year fire plots had all been burned 18 times, the four-year fire plots had all been burned 9 times, and the unburned plots had not been burned in >35 years.

Soil Field Measurements: Soil CO₂ flux was measured in situ approximately once per week throughout the 2016 growing season using a LiCOR 8100 portable gas exchange system (LiCOR Inc., Lincoln, NE, USA). In each study plot, two polyvinyl chloride (PVC) collars (10 cm diameter x 8 cm deep, buried 6 cm into the soil) were installed in a representative herbaceous community usually >1 m from the edge of the plot. In four-year burn and unburned plots that contained distinct and well-established woody plant communities, two additional collars were installed among patches dominated by woody plants (typically *Cornus drummondii*, Briggs et al., 2005). We surveyed these plots to estimate the percent cover by woody plants and by grasses. Collars were installed in the space between plant tillers/stems, and any litter was carefully removed from within each collar so that measurements included only CO₂ flux from the soil. Flux measurements required about 1 min and were taken approximately midday, between 1000 and 1500 Central Daylight Time. We focused on the period of highest soil CO₂ flux during the growing season (June - August), based on previous research in this grassland (Knapp et al., 1998b). Measurements were made more frequently during this time, and less frequently earlier and later in the growing season. Additional measurements were taken in April and May 2017 to confirm patterns in 2016.

Date of last update: 04/09/2020