

# NPP Grassland: Konza Prairie, USA, 1984-1990, R1

## Get Data

Revision Date: October 28, 2014

### Summary:

This data set contains three ASCII files (.txt format). Two files contain above-ground biomass and productivity data for a humid temperate tall-grass prairie grassland located in the Konza Prairie Natural Research Area, Kansas. One file provides data for an unburned treatment and the other for a burned treatment for 1975 to 1990. The third file contains climate data for the period 1891-1988 obtained from a weather station at Konza.

The above-ground net primary productivity measurement presented here (394 g/m<sup>2</sup>/year) is a 10-year average (1975-1984) based on peak seasonal live biomass values averaged for burned and unburned lowland and upland grasslands.

The Konza study site (39.10 N, - 96.61 W, Elevation 400 m) is situated near the town of Manhattan in north-eastern Kansas, about 170-km west of Kansas City. The Konza research program is built upon a long-term database on ecological pattern and process data derived from a fully replicated watershed-level experimental design, in place at the Konza Prairie Biological Station since 1977. This design includes replicate watersheds subject to different fire and grazing treatments. Within the watersheds, permanent sampling transects are replicated at various topographic positions, where plant species composition, plant and consumer populations, above-ground net primary production (ANPP), soil properties, and other key above- and below-ground processes are measured. In addition to these watershed-level studies, the [Konza Long Term Ecological Research \(LTER\) program](#) includes a number of long-term plot-level experiments.

**Revision Notes:** Only the documentation for this data set has been modified. The data files have been checked for accuracy and are identical to those originally published in 1996.

### Additional Documentation:

The NPP data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical forest, temperate forest, boreal forest, and tundra sites worldwide. Data were compiled from the published literature for intensively studied and well-documented individual field sites and from a number of previously compiled multi-site, multi-biome data sets of georeferenced NPP estimates. The principal compilation effort (Olson et al., 2001) was sponsored by NASA's Terrestrial Ecology Program. For more information, please visit the NPP web site at [http://daac.ornl.gov/NPP/npp\\_home.html](http://daac.ornl.gov/NPP/npp_home.html).

### Data Citation:

#### Cite this data set as follows:

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Knapp, A.K., and D. Ojima. 1996. NPP Grassland: Konza Prairie, U.S.A., 1984-1990. Data set. Available on-line [<http://daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

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## 1. Data Set Overview:

**Project:** Net Primary Productivity (NPP)

Productivity of a humid temperate tall-grass prairie was determined at the Konza Prairie Natural Research Area, Kansas, from 1975 to 1990. Monthly dynamics of above-ground plant biomass have been monitored since 1984, and estimates of above-ground plant production have been made since 1975.

Mid-season biomass values reported by Abrams et al. (1986) are peak seasonal values, except when extensive flowering of the grasses occurred late in the autumn. The 10-year annual means (1975-1984) in live biomass ( $x \pm S.E.$ ) were  $477 \pm 23$ ,  $389 \pm 33$ ,  $368 \pm 32$ , and  $340 \pm 26$  g/m<sup>2</sup>yr for burned and unburned lowland grasslands and burned and unburned upland grasslands, respectively. Scurlock and Olson (2013) report the average of these values (394 g/m<sup>2</sup>yr) as annual above-ground net production (ANPP). Olson et al. (2013a; b) report a similar value (180 gC/m<sup>2</sup>/yr) using a conversion factor of 0.45 to convert from grams of dry biomass to grams of carbon biomass (the difference presumably due to rounding).

The Konza Prairie was the site of the First ISLSCP (International Satellite Land Surface Climatology Project) Field Experiment (FIFE), an intensive period of remote-sensing and ground-based physiological and meteorological studies coordinated by NASA from 1987 to 1989. It is one of the National Science Foundation's Long Term Ecological Research (LTER) sites. The focal site for the Konza Prairie LTER program is the [Konza Prairie Biological Station \(KPBS\)](#), a 3,487 hectare native tall-grass prairie preserve owned by The Nature Conservancy and Kansas State University and operated as a field research station by the Kansas State Division of Biology.

The Konza research program is built upon a long-term database of ecological pattern and process data derived from a fully replicated watershed-level experimental design in place at KPBS since 1977. This design includes replicate watersheds subject to different fire and grazing treatments. Within the watersheds, permanent sampling transects are replicated at various topographic positions, where plant species composition, plant and consumer populations, soil properties, above-ground net primary production (ANPP), and other key above- and below-ground processes are measured. In addition to these watershed-level studies, the Konza LTER program includes a number of long-term plot-level experiments.

The Konza study site (39.10 N, -96.61 W, Elevation 400 m) is situated near the town of Manhattan in north-eastern Kansas, about 170 km west of Kansas City. The tall-grass prairie of East Kansas is typically grazed annually by domestic animals and would have been grazed by wild buffalo prior to the mid-19th century. Due to topography (undulating rocky hills of moderate slope), much of the surrounding Flint Hills region has not been converted to arable agriculture.

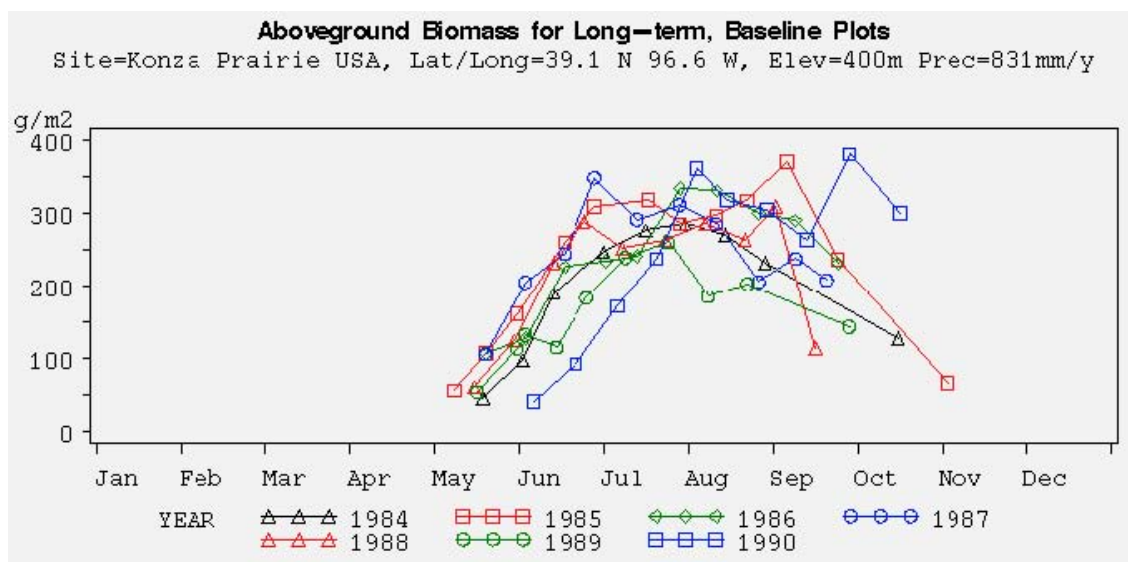


Figure 1. Aboveground Biomass Plot.

## 2. Data Description:

**Site:** Konza Prairie, Kansas, USA.

**Site Boundaries:** (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (m)
Konza Prairie, Kansas, USA.	-96.61	-96.61	39.10	39.10	400

### Spatial Resolution

There were twenty quadrats (each 0.1-m<sup>2</sup>) in each treatment area.

### Temporal Coverage

Biomass measurements reported in this data set were made from 1984/05/17 through 1990/10/15. Climate data are available from 1891/01/01 through

1988/12/31.

**Temporal Resolution**

Biomass measurements were made approximately bi-weekly during the growing season. All biomass estimates are based on plant dry matter accumulation, expressed as  $\text{g/m}^2$ . Climate data are expressed as monthly and annual precipitation amounts (mm) and monthly and annual average maximum/minimum temperature (C). Monthly and annual climatic means are provided for the 1891-1988 period.

FILE NAME	TEMPORAL COVERAGE	FILE CONTENTS
knz1_npp.txt	1984/05/17 - 1990/10/15	Above-ground biomass data for an unburned grassland at Konza Prairie Natural Research Area, USA
knz2_npp.txt	1984/05/17 - 1990/10/15	Above-ground biomass data for a burned grassland at Konza Prairie Natural Research Area, USA
knz_cli.txt	1891/01/01 - 1988/12/31	Monthly and annual climate data from the weather station at Konza Prairie Natural Research Area, USA

**NPP data:** Biomass estimates for the Konza site are provided in two files, one for each treatment (Table 1). The data sets are ASCII files (.txt format). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semi-colons. There are no missing values. All above-ground biomass units are reported as  $\text{g/m}^2$  (dry matter weight). The values are the average of 20 productivity measurements in each treatment area for each sampling date (i.e., above-ground biomass values for each study plot summed and then divided by 20). The above-ground biomass value for the unburned grassland does not include dead biomass from the previous year.

Table 2. Column headings in NPP files **knz1\_npp.txt** and **knz2\_npp.txt**

COLUMN HEADING	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	Text
Treatmt	Long term management of site (code refers to treatment described in metadata in data file; number refers to study site)	Text
Yr	Year in which data were collected	Numeric
Mn	Month in which data were collected	
Dy	Day on which data were collected	
Tyear	Date in decimal year (year plus the Julian date divided by 365)	
AGbiomass	Monthly above-ground living biomass	$\text{g/m}^2$

Note: Above-ground biomass estimates were extracted from the KPBS database (file PAB013). Note: Above-ground biomass estimates were extracted from the KPBS database (file PAB013).

**Sample NPP Data Record: knz1\_npp.txt**

```
Site;Treatmt;Year;Mn;Dy;Tyear;AGbiomass
knz;1_ingtrm;1984;05;17;1984.380; 45.4
knz;1_ingtrm;1984;06;01;1984.420; 96.5
knz;1_ingtrm;1984;06;12;1984.450; 190.2
...
```

**Sample NPP Data Record: knz2\_npp.txt**

```
Site;Treatmt;Year;Mn;Dy;Tyear;AGbiomass
knz;2_burned;1984;05;17;1984.380; 17.6
knz;2_burned;1984;06;01;1984.420; 96.9
knz;2_burned;1984;06;12;1984.450; 211.3
...
```

**Climate Data.** The climate data set is an ASCII file (.txt format). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semicolons. The value -999.9 is used to denote missing values.

COLUMN HEADINGS	DEFINITION
Site	Unique 3-character code for each site based on the first three consonants in the site name (e.g., knz for Konza)
	Indicates whether the values in that row are either long-term (i.e, multit-year) or annual data for the specified parameter.

Temp (Temporal)	<p>For multi-year, the values are:                  mean=mean values (monthly and annual) calculated for the years of data as noted in the documentation                  numb=number of years of data included in a reported mean value                  stdv=standard deviation of a mean value</p> <p>Annual data: 19XX=monthly and annual parameter values for the specified year (e.g., 1972)</p>
Parm	<p>Parameter, indicates the meteorological data reported in that row.                  prec-total precipitation for the month or year                  tmax=maximum temperature for the month or year reported in degrees C                  tmin=minimum temperature for the month or year reported in degrees C</p>

**Description of specific Temp and Parm data values:**

Long-term data:

site;mean;prec;  
 Multi-year mean of total precipitation for each month [Jan, Feb, Mar, ..., Dec] and mean of total annual precipitation across all years [Year] (mm)

site;mean;tmax;  
 Multi-year mean of maximum temperature for each month [Jan, Feb, Mar, ..., Dec] and mean of annual maximum temperature across all years [Year] (C)

site;mean;tmin;  
 Multi-year mean of minimum temperature for each month [Jan, Feb, Mar, ..., Dec] and mean of annual minimum temperature across all years [Year] (C)

... site; numb and stdv; repeat for prec, tmax, and tmin;

Annual data:

site;19XX;prec;  
 Total precipitation for each month [Jan, Feb, Mar,.....Dec] and total precipitation for the year 19XX [Year] (mm)

site;19XX;tmax;  
 Maximum temperature for each month [Jan, Feb, Mar,.....Dec] and maximum for the year 19XX [Year] (C)

site;19XX;tmin;  
 Minimum temperature for each month [Jan, Feb, Mar,.....Dec] and minimum for the year 19XX [Year] (C)

... site;19XX;(prec, tmax, and tmin); repeat for reported years.

Annual data missing value note: If a monthly parm value is missing, the parm value for [Year] is also set to missing (-999.9).

**Sample Climate Data Record**

Site;Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year  
 knz;mean;prec; 19.9; 28.3; 48.6; 72.8;115.2;128.8; 99.7; 96.6; 94.6; 63.4; 39.4; 24.3; 831.5  
 knz;mean;tmax; 3.9; 6.8; 13.1; 20.0; 24.9; 30.2; 33.4; 32.8; 28.2; 21.8; 12.9; 6.0; 34.1  
 knz;mean;tmin; -8.0; -5.9; -0.5; 6.0; 11.7; 17.1; 19.6; 18.8; 14.1; 7.3; -0.2; -5.6; -9.0  
 knz;numb;prec; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0  
 knz;numb;tmax; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0  
 knz;numb;tmin; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0; 98.0  
 knz;stdv;prec; 18.3; 22.5; 36.1; 42.4; 60.8; 73.4; 73.7; 69.9; 58.0; 45.4; 38.9; 20.8; 197.7  
 knz;stdv;tmax; 3.3; 3.6; 3.6; 2.3; 2.0; 2.2; 2.4; 2.4; 2.2; 2.5; 2.2; 2.9; 2.2  
 knz;stdv;tmin; 2.8; 3.0; 2.5; 1.9; 1.9; 1.5; 1.5; 1.7; 1.8; 2.1; 2.0; 2.5; 2.5  
 knz;1891;prec; 42.0; 21.0; 57.0; 13.0;122.0;189.0;115.0; 25.0; 37.0; 62.0; 7.0; 28.0; 718.0  
 knz;1891;tmax; 4.8; 5.4; 6.7; 21.8; 23.0; 27.3; 29.2; 32.7; 28.3; 20.3; 9.3; 8.4; 32.7  
 knz;1891;tmin; -6.2; -8.6; -4.2; 6.9; 9.6; 16.3; 16.8; 16.6; 16.9; 6.0; -1.1; -0.4; -8.6  
 ...

Where,  
 mean = mean based on all years  
 numb = number of years  
 stdv = standard deviation based on all years  
 Parm (parameter):

prec = precipitation for month or year (mm)  
 tmax = mean maximum temperature for month or year (C)  
 tmin = mean minimum temperature for month or year (C)

### 3. Data Application and Derivation:

The accumulation of biomass, or NPP, is the net gain of carbon by photosynthesis that remains after plant respiration. While there are many fates for this carbon, this data set accounts for above-ground growth. The above-ground net primary productivity measurement presented here (394 g/m<sup>2</sup>/yr) is a 10-year average based on peak seasonal live biomass values averaged for burned and unburned lowland and upland grasslands.

Overall, the Konza site has features representative of the pre-settlement tall-grass prairie in the United States, with fire and large native herbivores incorporated as a shifting mosaic. Thus, Konza Prairie serves as a benchmark for detecting and exploring the causes and consequences of environmental change taking place throughout the grasslands of the eastern Central Plains, with results relevant to mesic grasslands worldwide.

The results of this study can be used to evaluate the effects of fire on above-ground primary production in a native tall-grass prairie. This natural prairie also serves as a reference site from comparison to manipulated agricultural systems. The grassland monthly biomass dynamics data for the Konza grassland site are provided for comparison with models and estimation of NPP. Climate data are provided for use in driving ecosystem/NPP models.

### 4. Quality Assessment:

Studies at Konza indicate that, at a given topographic position, harvesting at least twenty 0.1-m<sup>2</sup> quadrats at the time of peak biomass (mid- to late-August) and combining current year dead biomass (separated from previous year dead biomass at sites not subjected to fire) with green biomass provides an acceptable estimate of annual ANPP with a standard error of less than 10% of the mean. Moreover, such treatments have sufficiently low variance to statistically detect differences between treatments when mean values differ by 20% or more (Briggs and Knapp, 1991; Knapp et al., 1998).

### 5. Data Acquisition Materials and Methods:

#### Site Information

The Konza study site (39.10 N, -96.61 W, Elevation 400 m) is situated near the town of Manhattan in north-eastern Kansas, about 170 km west of Kansas City. Over 90% of the vegetation at Konza is primarily native tall-grass prairie (modified Bailey ecoregion humid temperate prairie, #251/255) dominated by perennial C4 grasses, such as *Andropogon gerardii*, *Sorghastrum nutans*, *Panicum virgatum*, and *Schizachyrium scoparium*. Numerous sub-dominant grasses, forbs and woody species contribute to prairie's high floristic diversity. Plant lignin content at the study site was measured at 11.8 % (above-ground) and 13.7% (below-ground). Soil type was clay loam (sand/silt/clay 0.25/0.35/0.40) with a pH of 6.8. Soil carbon content was 2.0% OM and nitrogen content 0.2%. Due to topography (undulating rocky hills of moderate slope), much of the surrounding Flint Hills region has not been converted to arable agriculture.

Konza Prairie is one of the National Science Foundation's Long Term Ecological Research (LTER) sites. The focal site for the Konza Prairie LTER program is the Konza Prairie Biological Station (KPBS). KPBS is a 3,487 hectare native tall-grass prairie preserve owned by The Nature Conservancy and Kansas State University and operated as a field research station by the Kansas State Division of Biology.

Konza Prairie is managed to provide an array of burning and grazing (especially bison) treatments to facilitate research to evaluate the effects of fire and grazing on plant composition, primary production, consumer density and diversity, nutrient dynamics, soil chemistry, and hydrology. This natural prairie also serves as a reference site from comparison to manipulated agricultural systems.

Fire, started by both lightning and aboriginal man, influenced patterns and processes in the primary tall-grass prairie. To understand these effects, a series of spring burning treatments are maintained on watershed units. Experimental areas are burned at 1, 2, 4, 10, and 20 year intervals. These experimental burns are conducted in April before the dominant warm-season grasses begin active growth. Treatment boundaries follow watershed divides to facilitate analysis of hydrologic and nutrient responses to fire and frequency of fire. An extensive soil water/ground water monitoring system has been installed by the USGS on one of these watersheds. Bison were introduced into a fenced area of nearly 500 ha encompassing several different burn treatments in 1987. The area affected by bison was enlarged to 1,100 ha in 1991.

Bison, free-ranging within the fenced area, are able to choose between burned and unburned prairie and among sites representing an array of topographic/physiographic conditions. Cattle grazing still occurs sporadically on parts of Konza Prairie but not on the primary LTER research watersheds.

Konza has a continental climate characterized by warm, wet summers and dry, cold winters. Mean annual precipitation is sufficient to support woodland or savanna vegetation; consequently, drought, fire and grazing are important in maintaining this grassland.

#### Methods

Above-ground biomass was clipped bi-weekly during the growing season from twenty 0.1-m<sup>2</sup> quadrants along a transect in two Konza treatment watersheds (K001a burned and K020a unburned) from 1984/05/17 through 1990/10/15. All clipped plots are marked with flags. At the end of the season, the two ends of the transect were marked with metal flags imprinted with the year clipping took place. A large area was available for clipping, thus re-sampling the same areas was not a problem.

In the field, all biomass was clipped at ground level and bagged in burned watersheds but in unburned sites, the current year growth was separated from the previous year dead biomass and bagged separately. In the lab, the current year growth bags were sorted into live grass/sedges, current year dead grass/sedges, and current year forb/shrub components. The previous year dead was also examined to make sure no live biomass accidentally was included in this category in the field; previous year dead was not included in biomass weights in this data set (but are included in the original KPBS database used to construct this data set). Thus, each quadrat is sorted into two components in burned watersheds and three components in unburned



prairie. (Beginning in 1992, woody plants are separated from forbs, yielding an additional component category per treatment area.) All sorted samples are oven-dried at 60 degrees C for 48 hours before weighing.

Data from an earlier study (Abrams et al., 1986) was used to estimate ANPP over a 10-year period (1975-1984) based on peak seasonal live biomass values averaged for burned and unburned lowland and burned and unburned upland soils.

**Climate data**

The climate data accompanying this NPP data set was compiled from daily observations of Tmax, Tmin, and precip amount.

For a given month, the maximum value of the daily Tmax for that month and the minimum value of the Tmin for that month is provided. For the year, the maximum value of the monthly Tmax is the annual Tmax and for the year the minimum value of the monthly Tmin values is the annual Tmin. Daily precipitation amount is summed to yield a monthly precipitation amount and the monthly precipitation is summed to provide an annual precipitation amount.

The multi-year mean monthly Tmax is the average of the Tmax values for that month for each year of the record. For example the mean monthly Tmax for April is the mean of each April's Tmax for the observation period of record. Mean monthly Tmin and Mean monthly precip amount are calculated similarly.

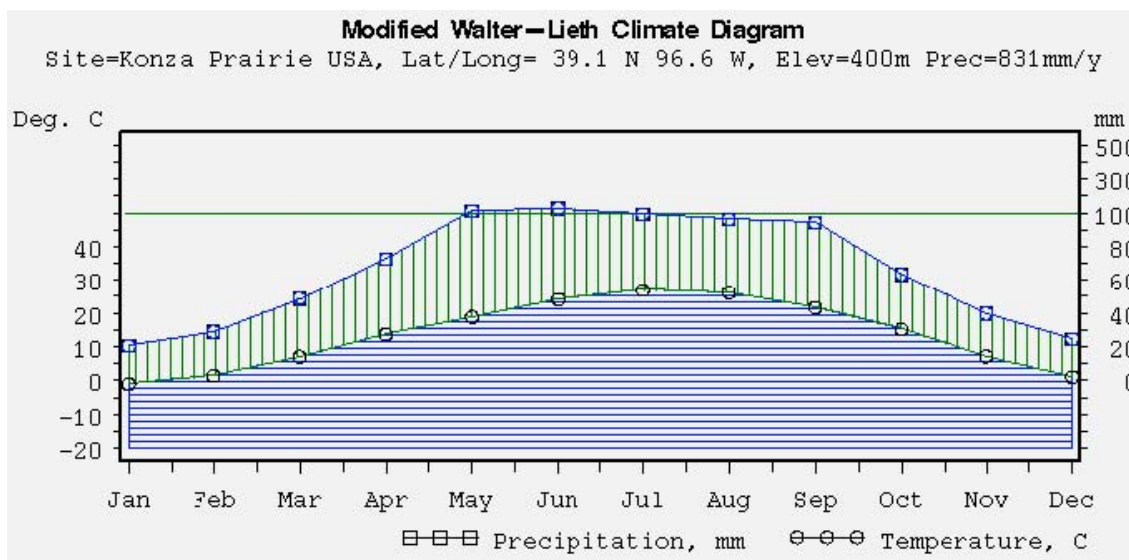


Figure 2. Modified Walter-Lieth climate diagram based upon mean temperature and precipitation data for the Konza grassland site, Kansas, USA. (criss-cross red shading, where present - period of relative drought; vertical green shading - period of relative humid season)

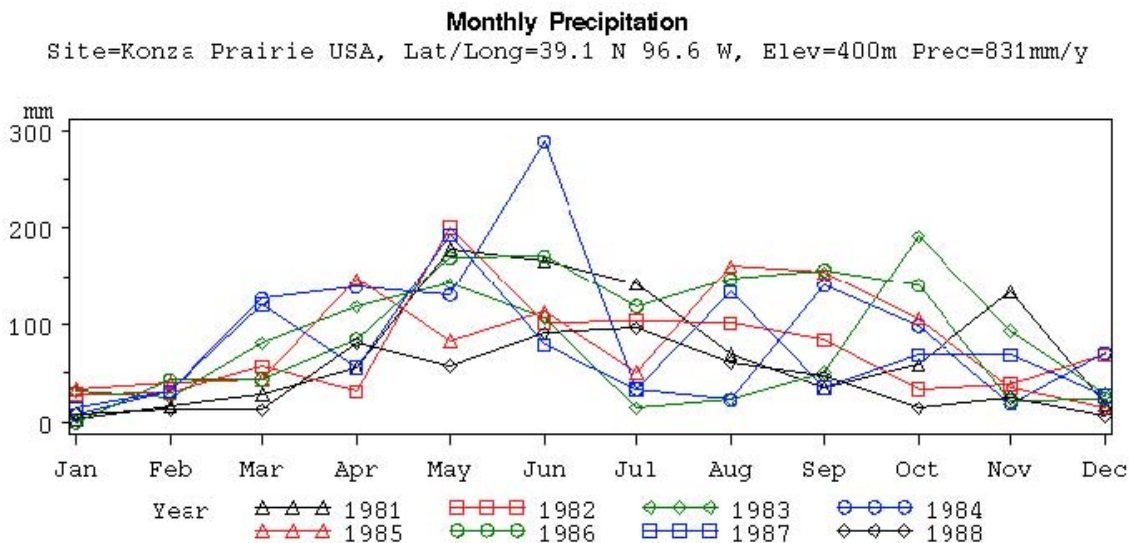


Figure 3. Monthly precipitation for each year of biomass data at the Konza grassland site, Kansas, USA.

**6. Data Access:**

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### Data Archive Center:

#### Contact for Data Center Access Information:

E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)

Telephone: +1 (865) 241-3952

## 7. References:

Abrams, M.D., A.K. Knapp, and L.C. Hulbert. 1986. A ten year record of above-ground biomass in a Kansas tallgrass prairie: effects of fire and topographic position. *American J. Botany* 73: 1509-1515.

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#### Additional Sources of Information:

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