Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara Conrad, Editors

Volume 213

BOREAS TF-11 Decomposition Data over the SSA-Fen

David W. Valentine
University of Alaska, Fairbanks

November 2000
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National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000
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Summary

The BOREAS TF-11 team collected several data sets in its efforts to fully describe the flux and site characteristics at the SSA-Fen site. This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted in 1994 as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m² as wheat straw) and nitrogen (6 g/m² as urea) to four replicate locations in the vicinity of the TF-11 tower. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification
BOREAS TF-11 Decomposition Data over the SSA-Fen

1.2 Data Set Introduction
This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m² as wheat straw) and nitrogen (6 g/m² as urea) to four replicate locations in the vicinity of the Tower Flux (TF)-11 tower.
1.3 Objective/Purpose
Much of the area within the boreal forest biome consists of wetlands, in which large carbon stores and high water tables drive fundamentally different atmospheric interactions than occur under the other forest types studied by the BORreal Ecosystem-Atmosphere Study (BOREAS). One key difference is in the form carbon is emitted following soil microbial respiration; in wetlands, much of it is emitted as methane. Wetlands are the dominant influence of boreal forests on atmospheric methane.

This study was undertaken in order to assess responses of methane emissions in northern wetlands to potential changes in plant productivity, nitrogen availability or both. Whiting and Chanton (1993) recently observed that methane emissions from wetlands across the globe are well related to net primary productivity (NPP). This may be for a variety of reasons, including enhanced plant transport, increased methanogenic substrates from root exudates, increased litter input cascading to enhanced substrate availability for methanogenesis, or enhanced C and N mineralization of decomposing residues. Previous work by us (Valentine et al., 1994) and others has shown that substrate availability is a key constraint on methane production in wetlands. The present study was an effort to test whether substrate manipulation results from laboratory studies could be mirrored under field conditions.

1.4 Summary of Parameters
We report the mass loss of a standard plant material (wheat straw) over the course of ~50 days as a function of treatment and location. We also report the initial and final concentrations of carbon and nitrogen (mass basis).

1.5 Discussion
These data were collected from a set of small locations within the fen, and therefore no one location represented the entire study site. In fact, the fen in which this work was conducted was characterized by a large-scale gradient of vegetation, microtopography, and hydrology such that the study site itself is representative only of the portion of the fen in which it was located (i.e., the lower 1/3).

1.6 Related Data Sets
BOREAS TE-06 Biomass Estimate Data
BOREAS TE-18 Biomass Density Image of the SSA
BOREAS TGB-03 Plant Species Composition Data over the NSA-Fen

2. Investigator(s)

2.1 Investigator(s) Name and Title
David Valentine
Assistant Professor
Department of Forest Sciences
P.O. Box 757200
University of Alaska
Fairbanks, AK 99775-7200

2.2 Title of Investigation
Influence of Substrate Characteristics and Other Environmental Factors on Methane Emissions from the BOREAS Southern Study Area Fen Site. III. Standard Litter Decomposition
2.3 Contact Information

**Contact 1:**
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**Contact 2:**
Jeffrey A. Newcomer  
Raytheon ITSS  
Code 923  
NASA GSFC  
Greenbelt, MD 20771  
(301) 286-7858  
(301) 286-0239 (fax)  
Jeffrey.Newcomer@gsfc.nasa.gov

3. Theory of Measurements

Litter bags were constructed from fiberglass screen to hold ~3 g of plant material. Once filled with wheat straw and weighed, they were placed within each of the treatment/location replicates and allowed to remain for ~50 days. They were then collected and reweighed, and the fraction of the original weight remaining is reported in the accompanying file.

4. Equipment

4.1 Sensor/Instrument Description
   Not applicable.

4.1.1 Collection Environment
   The litter bags were set out around the end of July (21-Jul or 02-Aug-1994), then retrieved on 17-Sep-1994. Half the bags were placed on the surface of the peat, and half were inserted 0.1 m below the surface.

4.1.2 Source/Platform
   Not applicable.

4.1.3 Source/Platform Mission Objectives
   Recent papers (e.g., Whiting and Chanton, 1993) have suggested that CH₄ emissions are positively related to plant productivity. One possible mechanism by which enhanced NPP or other factors may result in higher CH₄ emissions is through enhanced decomposition rates, perhaps indexing a more rapid substrate supply rate from fermentative processes. We therefore wanted to evaluate whether enhanced litter decomposition rates (i.e., mass loss) covaried with CH₄ emissions rates or varied as a function of our C and N additions.
4.1.4 Key Variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRAC</td>
<td>Not applicable</td>
<td>Fraction of wheat straw mass remaining</td>
</tr>
<tr>
<td>C</td>
<td>Not applicable</td>
<td>C fraction of wheat straw</td>
</tr>
<tr>
<td>H</td>
<td>Not applicable</td>
<td>H fraction of wheat straw</td>
</tr>
<tr>
<td>N</td>
<td>Not applicable</td>
<td>N fraction of wheat straw</td>
</tr>
</tbody>
</table>

4.1.5 Principles of Operation

Not applicable.

4.1.6 Sensor/Instrument Measurement Geometry

Not applicable.

4.1.7 Manufacturer of Sensor/Instrument

Not applicable.

4.2 Calibration

4.2.1 Specifications

Not applicable.

4.2.1.1 Tolerance

Not applicable.

4.2.2 Frequency of Calibration

Not applicable.

4.2.3 Other Calibration Information

Not applicable.

5. Data Acquisition Methods

Approximately 3 g of wheat straw was sealed into each fiberglass mesh screen. Oven dry equivalent weights for each were determined based on additional subsamples. Two replicate bags for each treatment/platform combination were either laid on the surface or inserted 0.1 m into the peat near the end of July, then collected in mid-September. Each bag was oven-dried at 30 °C for 48 h, then weighed. Subsamples were ground and analyzed using a Leco CHN analyzer for C, H, and N concentrations.

Subsamples from the initial (undecomposed) wheat straw were similarly analyzed for C, H, and N concentrations:

C_ADDED, N_ADDED, DURATION, REPlicate_ID, LITTER_MASS_FRACTION, C_CONC, H_CONC, N_CONC

Initial, 0, 0, 0, 0, 0, 1, .446, .061, .005

6. Observations

6.1 Data Notes

Vegetative growth lifted some of the bags off the peat surface during the decomposition period, and the resultant drying likely retarded those.

6.2 Field Notes

None.
7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage
All measurements were made along two transects identified by their location relative to the TF-11 micrometeorology tower: a north transect (NA and NB platforms) and a south transect (SA and SB platforms). All measurements were made within 70 m of the TF-11 tower, whose North American Datum of 1983 (NAD83) coordinates are 53.80206°N, 104.61798°W.

7.1.2 Spatial Coverage Map
Not available.

7.1.3 Spatial Resolution
The data are from point measurements at the given locations.

7.1.4 Projection
Not applicable.

7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
Litter bags were placed either on 21-Jul-1994 (north transect) or 02-Aug-1994 (south transect). All bags were collected on 17-Sep-1994.

7.2.2 Temporal Coverage Map
None.

7.2.3 Temporal Resolution
Ideally, the litter bags would have been placed at the beginning of the growing season. Because of a miscommunication from the Principal Investigator (PI) to the field crew, the bags were not placed until much later than optimal.

7.3 Data Characteristics

7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
</tr>
<tr>
<td>SUBSITE</td>
</tr>
<tr>
<td>START_OBS_DATE</td>
</tr>
<tr>
<td>END_OBS_DATE</td>
</tr>
<tr>
<td>PEAT_DEPTH</td>
</tr>
<tr>
<td>C_ADDED</td>
</tr>
<tr>
<td>N_ADDED</td>
</tr>
<tr>
<td>DURATION</td>
</tr>
<tr>
<td>REPLICATE_ID</td>
</tr>
<tr>
<td>LITTER_MASS_FRACTION</td>
</tr>
<tr>
<td>C_CONC</td>
</tr>
<tr>
<td>H_CONC</td>
</tr>
</tbody>
</table>
7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC,</td>
</tr>
<tr>
<td></td>
<td>where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and</td>
</tr>
<tr>
<td></td>
<td>TTT identifies the cover type for the site, 999 if unknown, and CCCCC is</td>
</tr>
<tr>
<td></td>
<td>the identifier for site, exactly what it means will vary with site type.</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>The identifier assigned to the sub-site by BOREAS in the format GGGGG-III,</td>
</tr>
<tr>
<td></td>
<td>where GGGGG is the group associated with the sub-site instrument, e.g. HYD06</td>
</tr>
<tr>
<td></td>
<td>or STAFF, and IIIII is the identifier for sub-site, often this will refer to</td>
</tr>
<tr>
<td></td>
<td>an instrument.</td>
</tr>
<tr>
<td>START_OBS_DATE</td>
<td>The date and time at which collection of the referenced data commenced.</td>
</tr>
<tr>
<td>END_OBS_DATE</td>
<td>The date and time at which collection of the referenced data was terminated.</td>
</tr>
<tr>
<td>PEAT_DEPTH</td>
<td>The depth below the peat surface.</td>
</tr>
<tr>
<td>C_ADDED</td>
<td>Estimated amount of carbon contained in the wheat straw that was added to</td>
</tr>
<tr>
<td></td>
<td>the plot.</td>
</tr>
<tr>
<td>N_ADDED</td>
<td>Estimated amount of nitrogen contained in the urea that was added to the plot.</td>
</tr>
<tr>
<td>DURATION</td>
<td>Duration of time that the samples were in the field since 21-JUL-94 or 02-</td>
</tr>
<tr>
<td></td>
<td>AUG-94.</td>
</tr>
<tr>
<td>REPLICATE_ID</td>
<td>Replicate id, where 2 denotes a replicate.</td>
</tr>
<tr>
<td>LITTER_MASS_FRACTION</td>
<td>Fraction of original litter mass remaining.</td>
</tr>
<tr>
<td>C_CONC</td>
<td>Carbon concentration of remaining littermass</td>
</tr>
<tr>
<td>H_CONC</td>
<td>Hydrogen concentration of remaining littermass</td>
</tr>
<tr>
<td>N_CONC</td>
<td>Nitrogen concentration of remaining littermass</td>
</tr>
<tr>
<td>SITE_COMMENTS</td>
<td>Descriptive information to clarify or enhance the site information.</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>The BOREAS certification level of the data. Examples are CPI (Checked by PI),</td>
</tr>
<tr>
<td></td>
<td>CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>The most recent date when the information in the referenced data base table</td>
</tr>
<tr>
<td></td>
<td>record was revised.</td>
</tr>
</tbody>
</table>
7.3.3 Unit of Measurement
The measurement units for the parameters contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE NAME</td>
<td>[none]</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>[none]</td>
</tr>
<tr>
<td>START_OBS_DATE</td>
<td>[none]</td>
</tr>
<tr>
<td>END_OBS_DATE</td>
<td>[none]</td>
</tr>
<tr>
<td>PEAT_DEPTH</td>
<td>[millimeters]</td>
</tr>
<tr>
<td>C_ADDED</td>
<td>[grams C][meter^-2]</td>
</tr>
<tr>
<td>N_ADDED</td>
<td>[grams C][meter^-2]</td>
</tr>
<tr>
<td>DURATION</td>
<td>[days]</td>
</tr>
<tr>
<td>REPLICATE_ID</td>
<td>[unitless]</td>
</tr>
<tr>
<td>LITTER_MASS_FRACTION</td>
<td>[unitless]</td>
</tr>
<tr>
<td>C_CONC</td>
<td>[grams C][grams litter^-1]</td>
</tr>
<tr>
<td>H_CONC</td>
<td>[grams H][grams litter^-1]</td>
</tr>
<tr>
<td>N_CONC</td>
<td>[grams N][grams litter^-1]</td>
</tr>
<tr>
<td>SITE_COMMENTS</td>
<td>[none]</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>[none]</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>[DD-MON-YY]</td>
</tr>
</tbody>
</table>

7.3.4 Data Source
The sources of the parameter values contained in the data files on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>[Assigned by BORIS Staff]</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>[Assigned by BORIS Staff]</td>
</tr>
<tr>
<td>START_OBS_DATE</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>END_OBS_DATE</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>PEAT_DEPTH</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>C_ADDED</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>N_ADDED</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>DURATION</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>REPLICATE_ID</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>LITTER_MASS_FRACTION</td>
<td>[Balance]</td>
</tr>
<tr>
<td>C_CONC</td>
<td>[Leco CHN analyzer]</td>
</tr>
<tr>
<td>H_CONC</td>
<td>[Leco CHN analyzer]</td>
</tr>
<tr>
<td>N_CONC</td>
<td>[Leco CHN analyzer]</td>
</tr>
<tr>
<td>SITE_COMMENTS</td>
<td>[Investigator]</td>
</tr>
<tr>
<td>CRTFCN_CODE</td>
<td>[Assigned by BORIS Staff]</td>
</tr>
<tr>
<td>REVISION_DATE</td>
<td>[Assigned by BORIS Staff]</td>
</tr>
</tbody>
</table>

7.3.5 Data Range
The following table gives information about the parameter values found in the data files on the CD-ROM.

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Minimum Data Value</th>
<th>Maximum Data Value</th>
<th>Missng</th>
<th>Unrel</th>
<th>Below Data Limit</th>
<th>Data Collectd</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE_NAME</td>
<td>SSA-FEN-FLXTR</td>
<td>SSA-FEN-FLXTR</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SUB_SITE</td>
<td>9TF11-DEC01</td>
<td>9TF11-DEC07</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>START_OBS_DATE</td>
<td>21-JUL-94</td>
<td>02-AUG-94</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>END_OBS_DATE</td>
<td>17-SEP-94</td>
<td>17-SEP-94</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

SITE_NAME, SUB_SITE, START_OBS_DATE, END_OBS_DATE, PEAT_DEPTH, C_ADDED, N_ADDED, DURATION, REPPLICATE_ID, LITTER_MASS_FRACTION, C_CONC, H_CONC, N_CONC, SITE_COMMENTS, CRTFCN_CODE, REVISION_DATE
'SSA-FEN-FLXTR', '9TFII-DECOI', 21-JUL-94, 17-SEP-94, 0, 300, 6, 58, 1, .87, .469, .061, .008, 'North of Tower, along transect A', 'CPI', 01-OCT-98
8. Data Organization

8.1 Data Granularity
The smallest unit of data tracked by the BOREAS Information System (BORIS) is the measurement(s) made for a given site on a given day.

8.2 Data Format(s)
The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae
Not applicable.

9.1.1 Derivation Techniques and Algorithms
None.

9.2 Data Processing Sequence

9.2.1 Processing Steps
None.

9.2.2 Processing Changes
None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
Not applicable.

9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
The most obvious source of error was the tendency for the litter bags to be lifted above the peat surface by vegetative growth, potentially retarding decomposition through excessive drying. Other sources of error include solubilization of straw constituents resulting in overstatement of decomposition rate, exclusion of soil fauna by the bag screen itself, and moss or other growth in the bag causing a mass gain during the period.
10.2 Quality Assessment

10.2.1 Data Validation by Source
   Not applicable.

10.2.2 Confidence Level/Accuracy Judgment
   Except for the bags that gained weight during the decomposition period, these data appear fairly robust. The aforementioned gainers should be deleted prior to analysis.

10.2.3 Measurement Error for Parameters
   Not applicable.

10.2.4 Additional Quality Assessments
   None given.

10.2.5 Data Verification by Data Center
   Data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
   See Sections 9.1 and 10.1.

11.2 Known Problems with the Data
   None given.

11.3 Usage Guidance
   See Sections 9.1 and 10.1.

11.4 Other Relevant Information
   None given.

12. Application of the Data Set

Several avenues are being pursued in publications now being produced to answer the following questions:
   • How do CH$_4$ flux measurements compare by technique used in measurement?
   • How and why do CH$_4$ flux measurements vary through time and across the landscape?
   • Does plant productivity limit CH$_4$ emissions?

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description
   We used only commercially available software, mostly the Quattro Pro spreadsheet.

14.2 Software Access
   Not applicable.
15. Data Access

The decomposition data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.
17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation
None.

17.2 Journal Articles and Study Reports


17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms
None.
19. List of Acronyms

- ASCII: American Standard Code for Information Interchange
- BOREAS: BOReal Ecosystem-Atmosphere Study
- BORIS: BOREAS Information System
- CD-ROM: Compact Disk-Read-Only Memory
- DAAC: Distributed Active Archive Center
- EOS: Earth Observing System
- EOSDIS: EOS Data and Information System
- GIS: Geographic Information System
- GSFC: Goddard Space Flight Center
- HTML: HyperText Markup Language
- NAD83: North American Datum of 1983
- NASA: National Aeronautics and Space Administration
- NPP: Net Primary Productivity
- NSA: Northern Study Area
- ORNL: Oak Ridge National Laboratory
- PANP: Prince Albert National Park
- PBR: Productivity/Biomass Ratio
- PI: Principal Investigator
- SSA: Southern Study Area
- TE: Terrestrial Ecology
- TF: Tower Flux
- TGB: Trace Gas Biogeochemistry
- URL: Uniform Resource Locator

20. Document Information

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20.5 Document Curator

20.6 Document URL
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<td>Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS) BOREAS TF-11 Decomposition Data over the SSA-Fen</td>
<td>923 RTOP: 923-462-33-01</td>
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<th>6. AUTHOR(S)</th>
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<tr>
<td>David W. Valentine Forrest G. Hall and Sara Conrad, Editors</td>
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<td>National Aeronautics and Space Administration Washington, DC 20546-0001</td>
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<td>The BOREAS TF-11 team collected several data sets in its efforts to fully describe the flux and site characteristics at the SSA-Fen site. This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted in 1994 as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m² as wheat straw) and nitrogen (6 g/m² as urea) to four replicate locations in the vicinity of the TF-11 tower. The data are stored in tabular ASCII files.</td>
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