NASA/TM—2000–209891, Vol. 1

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

*Forrest G. Hall and David E. Knapp, Editors*

## Volume 1
## BOREAS AFM-1 NOAA/ATDD Long-EZ Aircraft Flux Data Over the SSA

*T.L. Crawford, D. Baldocchi, L. Gunter, and E. Dumas*

National Aeronautics and
Space Administration

**Goddard Space Flight Center**
Greenbelt, Maryland 20771

June 2000

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# BOREAS AFM-1 NOAA/ATDD Long-EZ Aircraft Flux Data over the SSA

Timothy L. Crawford, Dennis Baldocchi, Laureen Gunter, Ed Dumas

## Summary

This data set contains measurements from the AFM-1 NOAA/ATDD Long-EZ Aircraft collected during the 1994 IFCs at the SSA. These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, $CO_2$ concentration, $O_3$ concentration, and $CH_4$ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular ASCII files.

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## 1. Data Set Overview

### 1.1 Data Set Identification
BOREAS AFM-01 NOAA/ATDD Long-EZ Aircraft Flux Data over the SSA

### 1.2 Data Set Introduction
This data set contains measurements from the National Oceanic and Atmospheric Administration (NOAA) Atmospheric Turbulence and Diffusion Division (ATDD) Long-EZ Aircraft collected during the 1994 Intensive Field Campaigns (IFCs) at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA). These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static

pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling photosynthetically active radiation (PAR), greenness index, $CO_2$ concentration, $O_3$ concentration, and $CH_4$ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular American Standard Code for Information Interchange (ASCII) files.

### 1.3 Objective/Purpose

The primary objective was to measure the vertical flux density of sensible and latent heat, $CO_2$, ozone, and momentum for extrapolating surface-based measurements to regional scales. An ultimate objective is to develop algorithms to relate boundary-layer processes to satellite-derived data.

The Airborne Fluxes and Meteorology (AFM)-01 team measured water vapor, sensible heat, $CO_2$, and $O_3$ air-surface exchange from the boreal forest to study the factors that control spatial variability of the exchange. Scalar flux densities were measured with ATDD's Long-EZ flux aircraft. The purpose of its flights was to observe energy, momentum, carbon, and ozone air-surface exchange with a 3-km resolution. Additionally, supporting meteorological parameters such as temperature, humidity, $CO_2$ and $O_3$ concentration, wind speed and direction, surface temperature, and incoming and net radiation were observed. All data were tagged with accurate time, position, and altitude. It is expected that these data will also be used to relate surface exchange to radiometric data available from satellites, i.e., validation of satellite data. Through this research, it is hoped that techniques can be developed to more accurately model air/surface exchange and to use satellite data for global monitoring of landscape health and climate change.

### 1.4 Summary of Parameters

The following parameters have been submitted to the BOREAS Information System (BORIS) data base: temperature, dewpoint temperature, pressure, incoming and outgoing PAR, net radiation, wind velocity, $H_2O$ mixing ratio, $CO_2$ mixing ratio, ozone mixing ratio, sensible heat flux, latent heat flux, momentum flux, $CO_2$ flux, $O_3$ flux, aircraft position, altitude (radar and pressure), and surface temperature.

Profile parameters are not available at this date.

### 1.5 Discussion

NOAA operated the Long-EZ in the one 1993 IFC and in all three 1994 IFCs. However, only the 1994 data are included in this data set. The main purpose of Long-EZ flights was to observe energy, momentum, ozone, and carbon dioxide air-surface exchange. The Long-EZ's strength is its ability to observe spatial variability in surface exchange with a 3-km resolution. This is accomplished by flying low (at 10 to 15 m above the surface) and slow (50 m/s) while making high-frequency eddy flux measurements. Due to the short sampling time of 60 s, the flux variance in the reported 3-km segments is large. However, each 3-km segment is an unbiased estimate of the mean, and variance can be reduced by transects' superposition. Ideally, six repeated transects should be superimposed. This is usually possible since a key element of the Long-EZ flight plans is repeated observations.

The data were collected during straight and level flux runs over the BOREAS site and in various project areas. A variety of flight strategies is reported (the Candle Lake transect, asterisks, grids, "L" patterns, soundings, etc.), from those described in the BOREAS experimental plan. The archive data include segment-averaged data, focusing on the fluxes, and the supporting meteorological, radiometric, and aircraft positional data. No attempt will be made to archive the high rate (40 Hz) "raw" or processed output data (POD), which can be acquired from ATDD by special request. The references give a complete description of the Long-EZ and its instrument systems. The following table gives a quick overview of flight operations.

| ITEM | IFC 93 | IFC 1 | IFC 2 | IFC 3 | TOTAL |
|---|---|---|---|---|---|
| Flight Hours | 46 | 83 | 75 | 68 | 272 |
| Old Jack Pine (OJP) Passes | 84 | 98 | 33 | 71 | 296 |
| Old Aspen (OA) Passes | -- | 44 | 47 | 23 | 114 |
| Old Black Spruce (OBS) Passes | -- | 37 | -- | 32 | 69 |
| Candle Lake | 15 | 35 | 55 | 32 | 137 |
| Grid Pattern | -- | -- | 5 | 3 | 8 |
| "L" Pattern | -- | 6 | 14 | -- | 20 |
| Calibrations | -- | 28 | 5 | 2 | 35 |
| Intercomparisons | -- | 18 | 8 | 2 | 28 |

NOTES: 1. Summary excludes experimental sampling patterns and miscellaneous sites. 2. Flight hours include all flight operations except ferry to and from Tennessee. 3. A pass is any flux tower crossing. Site-specific patterns such as "asterisk", 8's, and button holes were centered on the flux towers.

### 1.6 Related Data Sets

BOREAS AFM-02 Wyoming King Air 1994 Aircraft Flux and Moving Window Data
BOREAS AFM-02 Wyoming King Air 1994 Aircraft Sounding Data
BOREAS AFM-03 NCAR Electra 1994 Aircraft Flux and Moving Window Data
BOREAS AFM-03 NCAR Electra 1994 Aircraft Sounding Data
BOREAS AFM-04 Twin Otter Aircraft Flux Data
BOREAS AFM-04 Twin Otter Aircraft Sounding Data
BOREAS AFM-11 Aircraft Flux Analysis and Comparison PDF Documents

## 2. Investigator(s)

### 2.1 Investigator(s) Name and Title

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### 2.2 Title of Investigation

AFM-01: Experimental and Modeling Studies of Water Vapor, Heat and $CO_2$ Exchange over a BOREAL Forest

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## 3. Theory of Measurements

Air-surface exchange, or the surface flux, is a fundamental boundary condition controlling the atmospheric mass, momentum, and energy budgets. The species exchanged at the surface passes through the near surface boundary layer by turbulent transport. Thus, the surface exchange may be determined by measuring the near-surface turbulent or "eddy" flux. The eddy flux measurement is simple in concept, mathematically expressed as the covariance

$$F = \langle (rw)'s' \rangle \qquad 3.1$$

Here (rw)' is the turbulent fluctuation of the product of the dry air density and vertical velocity (i.e., dry air mass flux density), and s' is the turbulent fluctuation in the mixing ratio, relative to dry air, of the species of interest. The angle brackets indicate the appropriate ensemble average.

This method has a first-principles basis, and a direct noninvasive nature. Since the near-surface flux is directly observed, the only assumption is that the flux divergence or gradient between the measurement and the surface is small. This assumption is valid when the mean transport, sources, and storage terms within the conservation equation are small. The reliability of this assumption weakens with increasing measurement altitude, and/or increasingly complex atmospheric and site conditions.

The measurement principles for wind velocity and species concentration are well developed. Since the flux measurement is made above the surface without disturbing the surface, it cannot influence the exchange observed. Tower observations using a 15-min time scale, and airborne observations using a 3-km space scale, give data with sufficiently small time/space scale to permit the process studies needed to improve predictive capabilities. In the last 10 years, the accuracy of this technique has improved because of significant advancements in instrumentation and processing techniques.

However, the details associated with proper instrument operation, data processing, and data interpretations are complex. This is especially true for airborne flux systems. For aircraft, both the instrument systems and data processing programs are more complex when compared to tower systems. For example, to determine wind velocity on an aircraft, the air velocity relative to the sensors is added to the sensor velocity relative to Earth. Both vectors are large and nearly cancel each other out (i.e., similar magnitude, opposite signs). Neither vector can be directly observed, but must be synthesized from many sensors. The synthesis process is intolerant to phase or amplitude errors introduced by sensors, data systems, or processing algorithms.

### Eddy Flux Measurement Theory

The eddy flux method allows the short-term measurement of flux densities (vertical transport of mass, momentum, and energy per unit area and time). The measurement becomes especially powerful, but often difficult to interpret, when made from an aircraft. Aircraft turbulence data derive their power from information density per unit time, and the spatial freedom of the measurement platform. Both require greater effort in an analysis. Further, interpretation of aircraft data becomes more difficult whenever the data set also contains spatial trends and inhomogeneities. Mass conservation provides the basic framework for correct interpretation. Conservation of a conservative species, s, requires that the time rate of change of s within a control volume be balanced by the mean and turbulent flux through the volume's boundaries.

From the Long-EZ, fluxes are measured usually around 15 m above the surface (higher from other aircraft and lower from towers). The flux measurement accurately defines the flux occurring at the flight altitude and along the flight track. However, most are interested in the surface flux. The flux observed at a flight altitude represents the surface flux if the following conditions are met.

- The flight altitude is low enough to be within the constant flux layer. Above this, flux divergence becomes increasingly important with increasing altitudes, which makes the observed flux no longer representative of the surface flux. Such flux divergence usually causes an underestimate of the surface flux, but not always. Typically, mitigating concerns about flux divergence requires measurement within the lowest 10% of the turbulent boundary layer. With the exception of stable night boundary layers, the Long-EZ's 15 m sampling altitude satisfies this condition. However, the importance of storage and transport terms below the flight altitude should be considered. In unusual situations such as front passages, strong temperature, or species advection, such terms can still become significant.
- The underlying surface is homogeneous. It should extend upwind of the flight track for about 100 times the sampling altitude. Also, it should extend along the flight track for a distance equivalent to the space average being applied in data processing. This ensures the development of an equilibrium surface boundary layer and adequate sampling time before conditions change. Airplane measurements remain valid whether or not these conditions are met. However, small-scale inhomogeneity greatly increases the difficulty of specifying and interpreting the mean state from which the turbulence departs and introduces samples from multiple populations into the measurement set. This difficulty increases as the contrast between inhomogeneous regions increases.
- Stationary meteorological conditions should prevail during sampling. Such conditions as frontal passage and nightfall clearly violate this, featuring important contributions from the horizontal transport or storage terms, explicitly rejected by Eq. 3.1. However, less abrupt change can also be important. For example, if the air is warming 3 deg/hr, the heat flux at 15 m (Long-EZ flight level) will be 20 $W/m^2$ less than at the surface due to storage.
- Below the measurement height, s must be a conservative property. Fast chemical reactions involving s invalidate this assumption. For example, ozone reacts rapidly with NO. If there is a significant NO emission below the sampling altitude (soil flux or automobile emissions), it could easily lead to an incorrect interpretation of the observed flux.

### Eddy Flux Technique

A significant part of the complexity of this measurement lies in separating turbulent fluctuation from mean, and defining an appropriate ensemble average. Equation 3.1 is not computationally useful until the turbulent fluctuations are defined. Traditionally, the fluctuations are defined as

$$s = s' + S \qquad 3.2$$

where S is the appropriate ensemble mean of s.

Given this definition, Eq. 3.1 may be rewritten as

$$F = \langle[(rw) - (RW)](s - S)\rangle = \langle(rw)s - (RW)S\rangle \qquad 3.3$$

Here (RW) is not the product of the mean of the dry air density and the mean vertical velocity but the mean of their product. For heat flux, s =Cp*T where Cp is the moist air specific heat at constant pressure. Cp depends locally (i.e., at 40 Hz) on water vapor concentration. T is the potential temperature. The use of potential temperature compensates for the compressible nature of the atmosphere. Since there is a correlation between w and the aircraft altitude, the use of potential temperature is necessary to eliminate this false (rw)t correlation. For latent heat flux, s = Lq where L is the local temperature-dependent evaporation energy for water and q is the water vapor mixing ratio relative to dry air. For $CO_2$, s becomes the $CO_2$ mixing ratio relative to the dry air component. This approach satisfies the constraint outlined by Webb et al. (1980) (no flux of dry air), and implicitly corrects all fluxes for heat and water vapor transport.

On a tower, the mean is a time average. The fluctuation is then obtained as s' = s - S where S is the average over periods of around 15 to 30 min. However, s observed from an airplane contains both space- and time-related trends. In aircraft flux data, a space trend should also be considered. This is a tedious and difficult correction that requires much investigator interpretation. Only time trends have been removed for data submitted to BORIS.

Eddies in a wide range of scales contribute to turbulent transfer. Successful eddy flux measurement requires proper sampling over this spectrum. The eddy size is expressed by a dimensionless frequency, nz/u, where n is the eddy size as a frequency, z the sampling height, and u the eddy transport speed past the sensor. The important eddy size ranges contributing to turbulent transfer are typically within 0.005 < nz/u < 5. For the Long-EZ, u = 50 m/s and z = 10 m. Therefore, from the Long-EZ, eddy sizes between 1.25 m and 1,250 m are important. Over deciduous forest during typical daytime turbulent conditions, little flux contribution occurs outside this range (Anderson et al. (1986)). However, due to the greater roughness of the BOREAS site, we suspect the important eddy flux range may be driven to longer wavelengths. The nz/u scaling points out the need for and advantage of fast-response turbulent measuring systems. Fast-response sensors/data systems combined with low-altitude flying allow the contributing eddies to be sampled in a shorter time and enhance the spatial resolution of the flux observation.

The significant heterogeneity of the BOREAS experimental site makes it difficult quantitatively to specify the important eddy-size range contributing to turbulent transfer. Traditional spectral analysis is not appropriate due to strong site heterogeneity. To address this issue, two Candle Lake transects were processed with various covariance time scales or wavelength. The average flux along the transect normalized by the largest covariance result is presented in the following table. As the table shows, little flux is lost even at 20 s; therefore, our 60-s choice for BORIS submission is conservative.

| Wavelength | U* | H | LE | Flux$CO_2$ |
|---|---|---|---|---|
| 5 s (250 m) | 0.05 | 0.7 | 0.7 | 0.8 |
| 10 s (500 m) | 0.69 | 0.9 | 0.8 | 0.9 |
| 20 s (1000 m) | 0.39 | 0.9 | 0.9 | 0.9 |
| 30 s (1500 m) | 0.24 | 0.9 | 0.9 | 0.9 |
| 40 s (2000 m) | 0.16 | 0.9 | 0.9 | 0.9 |
| 60 s (3000 m) | 0.10 | 0.9 | 0.9 | 0.9 |
| 80 s (4000 m) | 0.01 | 1.0 | 0.9 | 0.9 |
| 100 s (5000 m) | 0.03 | 0.9 | 1.0 | 1.0 |
| 110 s (5500 m) | 0.00 | 0.9 | 0.9 | 0.9 |

Evaluating the accuracy of the eddy correlation method is not straightforward. Factors contributing to uncertainties are instrument errors, sensor time response, signal-to-noise ratio, sensor separation distance, height of the measurement, signal attenuation due to path averaging, and corruption through tubing. Natural variability, due to nonsteady conditions, turbulence intermittency, and surface inhomogeneities, can add additional uncertainty. Under ideal meteorological and site conditions, natural variability is around ±10%. Therefore, systems should be designed with an error less than this. However, the biggest problems with aircraft data are not related to data accuracy, but to data interpretations. Aircraft data implicitly represent a space average. The spatial variance is usually larger than 10%.

# 4. Equipment

## 4.1 Sensor/Instrument Description

The equipment used for the airborne flux measurement includes ATDD's Long-EZ flux research aircraft, the airborne flux instrumentation, and ATDD's data reduction hardware with software. These three systems were specifically designed and manufactured by ATDD staff to ensure high-fidelity flux observations. The optimum use of this airborne system is boundary layer flux measurement.

### Long-EZ Description

The Long-EZ flux research aircraft, N3R, is well suited and is specifically instrumented for high-fidelity, air-surface-exchange research (Crawford et al., 1996). The wide-body Long-EZ is an experimental aircraft built by Timothy L. Crawford. It is a larger, higher-powered, and more capable version of the Rutan Long-EZ, a two-passenger, high-performance canard airplane. The aerodynamic characteristics of the Long-EZ are well suited for high-fidelity turbulent flux measurement. The pusher configuration leaves the front of the airframe free of propeller-induced disturbance, engine vibration, and exhaust. The small, laminar-flow airframe has an equivalent flat plate drag area of 0.2 $m^2$. As a result, the nose region has small flow disturbance and is ideal for high-fidelity measurements of winds, temperature, and trace species. The canard design cannot stall and has superior pitch stability in turbulent conditions. This, combined with its low wing loading, allows for safe low-speed (50 m/s), low-altitude (10 m) flux measurement. For enhanced safety, the Long-EZ is equipped with a ballistically deployed safety parachute (deployment requires 0.9 s).

The Long-EZ has an empty weight of 430 kg and a maximum gross takeoff weight of 800 kg. The aircraft service ceiling of 9,000 m must be reduced to 5,500 m because of oxygen system limitations. Endurance significantly exceeds 10 hours and a 2,000-nm range; however, pilot fatigue precludes routine 10-hour missions. More typical operations are two 4-hr or three 3-hr missions. Although small size (low flow distortion) is important to high-quality turbulence measurements, it is also a disadvantage. The small size combined with the current instrumentation leaves little room for additional instruments.

### Airborne Flux Instrumentation Description

Wind velocity and virtual temperature fluctuations were measured with ATDD's turbulence probe (Crawford and Dobosy, 1992). The probe is mounted five chord lengths ahead of the wings, where flow disturbance is small. It carries pressure, temperature, and acceleration sensors in a nine-hole pressure-sphere gust probe of ATDD design. This sensor suite is specifically designed to extend eddy flux measurement at the higher frequencies required for low altitude flight. A thermistor in the central pressure port provides simultaneous temperature measurement, at a location symmetrical with respect to the flow, for accurate determination of true air speed and heat flux. $CO_2$ and water vapor fluctuations were measured with an open-path, infrared gas absorption (IRGA) analyzer, developed at ATDD (Auble and Meyers, 1992). This sensor responds to frequencies up to 40 Hz and has low noise and high sensitivity (for $CO_2$, 20 mg/$m^3$/v). The sensor is rugged and experiences little drift. A unique difference in the Long-EZ instrument system is its pioneering use of a differential Global Positioning System (GPS) for extremely accurate position, velocity, and platform attitude measurement.

The airborne flux instrumentation and the data system with its associated software were specifically designed and built by ATDD (Crawford et al., 1991). This system connects to the pilot's digital interface, which controls instrument power distribution, two-way "smart" instrument communication, and the data-storage algorithm. The data stream is dominated by the high-frequency analog signals. Analog signals are first electronically conditioned by 30-Hz lowpass Butterworth anti-aliasing filters. The conditioned and voltage scaled signals are then digitized at 200 Hz. The 200-Hz data are digitally filtered and subsampled to 40 Hz. Although several other data frequencies are being written to disk, all are synchronized to a single clock frequency. Spectra and cospectra data analysis show that the 40-Hz flux data rate is adequate for measuring fluxes above forest canopies at the Long-EZ flight speed and altitude.

### Data Reduction Hardware with Software

The eddy flux densities are determined by calculating the covariance between vertical velocity and scalar fluctuations while correcting for aircraft speed variations (Crawford et al., 1993a).

### 4.1.1 Collection Environment

Data were collected during IFCs 1, 2, and 3 under flight conditions outlined in the BOREAS Flight Plans for flux aircraft.

#### 4.1.2 Source/Platform

The platform used to collect this data was a Long-EZ aircraft built by Timothy Crawford.

#### 4.1.3 Source/Platform Mission Objectives

The mission objective was to collect $CO_2$, $O_3$, and $CH_4$ concentrations as well as other atmospheric and radiation parameters over various BOREAS sites.

#### 4.1.4 Key Variables

The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, $CO_2$ concentration, $O_3$ concentration, and $CH_4$ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data.

#### 4.1.5 Principles of Operation

None given.

#### 4.1.6 Sensor/Instrument Measurement Geometry

ATDD's turbulence and heat flux probe is mounted on the airplane at the end of a 1-m nose boom. This places the probe five wing chords in front of the canard and six wing chords in front of the main wing. All high-frequency motion (acceleration, pressure, and temperature) sensors are within the nine-hole pressure sphere. The center of the sphere is the origin of the computational coordinate system. A backup fast-response temperature sensor and slow-response temperature sensor for calibration reference are mounted on the nose of the airplane along with ATDD's fast-response IRGA $H_2O/CO_2$ analyzer. Forward on the left side of the nose is the net radiometer. The small airframe size results in very small solid angle interference from the airframe at the nose. Located at the aircraft center of gravity (CG) are the low-frequency reference sensors for $H_2O$, $CO_2$, and $O_3$. The infrared surface temperature sensor, the chilled-mirror dewpoint hygrometer, and the fast-response $O_3$ analyzer are also at this location. The infrared temperature sensor is nadir-mounted through the floor. With its 15-degree field of view, it "sees" a 5-m-wide footprint. There are six GPS antennae strategically placed around the airframe, which are connected to three separate GPS receivers. The critical system is a four-antennae differential GPS (DGPS) attitude system. Attitude is determined by differentially measuring the relative positions, within 1 cm, of nose, tail and wing antennae. The current GPS is limited to operation at 4 Hz. A system upgrade with associated software enhancements is expected to allow this system to operate at 10 Hz in the future. When the attitude system output is increased to 10 Hz, one of the redundant GPS position receivers and the three-axis gyro system at the CG can be eliminated.

#### 4.1.7 Manufacturer of Sensor/Instrument

The microprocessor revolution has accelerated technological advancements in instrumentation. The instrumentation on the Long-EZ has been upgraded continuously to keep pace with instrument technology. Improved instrumentation is installed as it becomes available or is found desirable. Typically, several instruments change each year. The following table lists the instruments, manufacturer, location, sampling rate, accuracy, resolution, and units of the instruments that were onboard during BOREAS IFCs.

| Variable | Name | Manufacture/Model | Loc/Hz | Acc/Res | Unit |
|---|---|---|---|---|---|
| Acceleration | Ax | Sundstrand/QA-700 | P/40 | 25/10 | $m/s^2$ |
| Acceleration | Ay | Sundstrand/QA-700 | P/40 | 50/35 | $m/s^2$ |
| Acceleration | Az | Sundstrand/QA-700 | P/40 | 70/50 | $m/s^2$ |
| Pressure | Px | SenSym/SCX01 | P/40 | 70/0.6 | mb |
| Pressure | Py | SenSym/SCXL004 | P/40 | 50/0.5 | mb |
| Pressure | Pz | SenSym/SCXL004 | P/40 | 50/0.5 | mb |
| Dif Stc Pres | DelP | SenSym/SCXL004 | P/40 | 50/0.5 | mb |
| Static Pres | StP | Setra/270 (mod) | H/1 | 0.5/0.01 | mb |
| Attitude | Pitch | TANS VECTOR-Trimble | C/1 | 0.08/-- | deg |
| Attitude | Roll | TANS VECTOR-Trimble | C/1 | 0.08/-- | deg |
| Attitude | Head | TANS VECTOR-Trimble | C/1 | 0.05/-- | deg |
| Position | Lat | DGPS | P/1 | 3 / 3 | deg |
| Position | Lng | DGPS | P/1 | 3 / 3 | deg |
| Fast temp | Tp | ATDD/u-bead thermistor | P/40 | 0.1/0.005 | °C |
| Mean temperature | Mp | RPT/Hy-Cal BA-507-B | P/1 | 0.05/0.03 | °C |
| Dewpoint temp | Td | EG&G/ | C/1 | 0.5/0.006 | °C |
| Water vapor | fast | ATDD/IRGA | H/40 | ---/22 | $g/m^3$ |
| Water vapor | ref | LI_COR/6262 | C/1 | 1%/0.005 | mM/M |
| $CO_2$ | fast | ATDD/IRGA | H/40 | ---/0.2 | $mg/m^3$ |
| $CO_2$ | ref | LI-COR/6262 | C/1 | <1/0.2 | µM/M |
| $O_3$ | fast | ATDD/Chemiluminescence | C/40 | / | ppb |
| $O_3$ | ref | Modified TECO | / | / | ppb |

Notes: Sensor locations:
P - in pressure sphere;
H - on probe hatch mountcover;
C - Aircraft CG

### 4.2 Calibration

All instruments were calibrated before and after each IFC. Complex instruments (such as $CO_2$ and $O_3$) were calibrated daily. All instruments undergo a comprehensive pre- and post-flight check for correct operation. The first and last data file for each flight go through a quality assurance (QA) procedure prior to the next flight. As part of the QA, takeoff and landing meteorological data are checked against conditions observed at the airport. Additionally, all data undergo time-series display, statistical and spectral analysis, and preliminary data reduction as part of the QA procedure.

#### 4.2.1 Specifications

Not available.

##### 4.2.1.1 Tolerance

Not available.

#### 4.2.2 Frequency of Calibration

All instruments were calibrated before and after each IFC. Daily calibrations were performed on the $CO_2$ and $O_3$ instruments.

#### 4.2.3 Other Calibration Information

See Section 17 (References).

# 5. Data Acquisition Methods

Data were collected during IFCs 1, 2, and 3 under flight conditions outlined in the BOREAS Flight Plans for flux aircraft.

# 6. Observations

## 6.1 Data Notes

None.

## 6.2 Field Notes

**25 May 1994 Flight hours 4.4 (Hobbs) Pilot: TLC**
SUMMARY: Today's flight consisted of low-level agriculture runs in the SSA with entry in the western corridor, combined with a site specific asterisk pattern over Tower 5 (Old Jack Pine).
WEATHER: Mostly clear and sunny.
TAKEOFF: 1744Z, FSS Temp = 7.9 C, Dew Pt = 6.6 C
LANDING: 2045Z
NOTES: On ground met readings prior to flight: P = 969.1 mb, T = 25.9 C, Tw = 19.4 C NOTE: the on ground pre-flight T and Tw readings are probably wrong, due to a problem with the psychrometer. On ground met reading after the flight: P = 968.0 mb, T = 19.0 C, Tw = 13.7 C.

After flight: 1515 local time, zeroing LI-COR. Li-COR calibration with U.Wyo gases: $H_2O$: 0.45; $CO_2$: -1.8, so zero is real close to where it should be. Current pot settings are 2.4 ($CO_2$) and 5.0 ($H_2O$).

**26 May 19944.4 Flight Hours (Hobbs) Pilot: TLC**
SUMMARY: 2 profiles & 5 Candle lake runs at 20 m--very turbulent with strong wind. Note: The NCAR Electra flew the Candle Lake line during the same period from 100 m to above the boundary layer.
WEATHER: Started clear with 15% Cu building by mid run, some high stratus
TAKEOFF: 1550Z, FSS Temp 19.3 C; Dew Pt 7.0 Wind; 180/15
LANDING: 2000Z, FSS Temp 22.3 C; Dew Pt 6.1; Alt 29.84
NOTES: On ground met readings prior to flight: T=20 C, Tw=16.9 C, P=963.4 mb After flight met readings: T=22.3 C, Tw=13.3 C, P=961.3 mb

**26 May 1994 Flight hours 1.9 (Hobbs) Pilot: EJD**
SUMMARY: Flight plan was to fly a site specific, asterisk over the Old Aspen (OA) site in the SSA.*****NO GYROS FOR THE WHOLE FLIGHT*****
WEATHER: Mostly sunny, some clouds around, windy
TAKEOFF: 2030Z
LANDING: 2220Z
NOTES: On ground met readings prior to flight: T=22.3 C, Tw=13.3 C, P=961.3 mb
After flight met readings: T=22.5 C, Tw=12.7 C, P=960.2 mb.
Note: When processing data after the flight, it appears the gyros were OFF for the entire flight - not malfunctioning. Also, the ozone inlet came off sometime during the flight.

**27 May 1994 4.3 Flight Hours (Hobbs) Pilot: TLC**
SUMMARY: Two site specific runs - asterisks over the Black Spruce Tower, then one over the Old Jack Pine tower. $CO_2$ sensor was calibrated prior to flight.
WEATHER: On Takeoff, clear wx conditions - haze to East no clouds directly above, thin high stratus. Basically clear all day, with stratus building and coming in from the west at about 2000Z - 50%, from morning of about 15%. Note: BS not a good place for a site specific - there is a lot of heterogeneity: lot of little lakes, lot of chopped up stuff - lot of terrain - looking for the best direction that offers a good comparison with the tower. OJP coordinated from Piers 53.916N, 104.69W.
TAKEOFF: 1630Z FSS Temp 22 C
LANDING: 2030
NOTES: On ground met readings prior to takeoff: T=21.6 C, Tw=15.2 C, P=954.7 mb
After flight met readings: T=28 C, Tw=15.4 C, P=952.4

**29 May 1994 Flight hours 2.8 (Hobbs) Pilot: TLC**
SUMMARY: An OJP site asterisk plan was flown. In conjunction, the Twin Otter was flying an "L" pattern across all tower sites, and the NASA helicopter took measurements in the same area. CO2 IRGA calibration was done prior to flight, so there is an updated zero and span available. Additionally, the probe temperature sensor was changed from the glass microbead to the wire microbead; therefore, the zero and span of the temperature probe has changed.
WEATHER: Overcast most of the day. At P.A.: cloud est to be 3200 Sct, 9000Bkn, 25000 Bkn, vis 15 miles. It was more cloudy to the southwest when over the site. At landing, a system had moved in from the south, and lite precipitation had begun.
TAKEOFF: 1740Z
LANDING: 2020Z
NOTES: The date and time were set incorrectly, so the first file has the wrong time. The GPS reset the time when the file was closed. he date had been 27 May, (edited after the flight).

**31 May 1994 Flight hours 5.4 hours (Hobbs) Pilot: TLC**
SUMMARY: The flight plan consisted of an intercomparison with the Canadian TO to the grid where the TO was to sample. After that, the Long-EZ flew 7-Candle Lake runs. The NCAR Electra also flew the Candle Lake run.
WEATHER: Clear in the morning, small cumulus by mid-morning, with increasing cloud cover by mid-afternoon. Maximum coverage 25% by the afternoon. Note: No ozone instruments installed (fast or slow). Repaired DelP sensor. "Hell-hole" access taped up, trying to reduce pressure in cabin to better ventilate the temperature probe.
TAKEOFF: 1615Z FSS Temp = 16.6 C, Dew Pt = 7.1 C, winds 300/5, alt 30.11 LANDING: 2120Z

**1 June 1994 Flight hours 5.1 hours (Hobbs) Pilot: TLC**
SUMMARY: Flight plan consisted of asterisks first over BS and OJP, then a Candle Lake run with the Twin Otter for intercomparison, followed by an asterisk over Old Aspen.
WEATHER: Initially clear (0800L), then clouding over by mid-morning to noon. By landing, the sky was 90% coverage. Calibration of IRGA recorded to disk prior to flight - 3 concentrations: 301.5, 365.8, 415 ppm. Also, radar altimeter failed on the last few files of the prior flight. And, there are no Magellan or ozone instruments.
TAKEOFF: 1445Z FSS Temp=18.2, Dew Pt = 7.6, alt 30.14, winds 120/10
LANDING: 2000Z

**1 June 1994 Flight hours 2.6 (Hobbs) Pilot: EJD**
SUMMARY: Flight plan was an asterisk over the Old Aspen site, then a few low passes over the Black Spruce site (for the press). Tape recorder failed, so there are no inflight remarks.

**2 June 1994 Flight hours 1.1 hours (Hobbs) Pilot: EJD**
SUMMARY: Purpose of flight was to do a pitch and wind cal at constant altitude, i.e., speed ups/downs, wind box, wind circle.
WEATHER: Overcast, lite precip.
TAKEOFF: 1450Z
LANDING: 1550Z FSS T = 17, Dew Pt = 8

**4 June 1994 Flight hours 2.2 (Hobbs) Pilot: TLC**
SUMMARY: This was a calibration, wind box, wind circle, speed pitch up/dn flight. The radar altimeter is back up and working fine. The ozone instruments are still out.
WEATHER: Calm, stable condition. The winds are very light and out of the NE. The haze from the paper plant was in the area, and some crud clouds were in the south. By landing, it was starting to clear out...minor wind shift.
TAKEOFF: 1200Z FSS Temp = 9.4, Dew pt = 9.2, alt 29.89, winds calm
LANDING: 1400Z FSS Temp = 15., Dew pt = 12., alt 29.89, winds calm
NOTES: Notes on landing: looking at paper mill, the winds seem to be 210 deg at the surface, then about 230 deg aloft.

**4 June 1994 Flight hours 4.5 (Hobbs) Pilot: TLC**
SUMMARY: Candle Lake runs coupled with an intercomparison with the Wyoming King Air.
WEATHER: Clear, calm, and mostly sunny. Some cumulus forming.
TAKEOFF: 1500Z FSS T = 16.8, Td = 11.9, winds calm, alt 29.89
LANDING 1930Z FSS T = 22.7, Td = 9.6
NOTES: Magellan GPS not working all morning. The ozone instruments are out.

**4 June 1994 Flight hours 2.8 (Hobbs) Pilot: EJD**
SUMMARY: Originally there was to be an asterisk to be done over OJP; however, it was precipitating over the site, so an asterisk was done over the Black Spruce site.
WEATHER: By mid-afternoon, there was about 50% cloud cover, mixed types, mostly Cu.
TAKEOFF: 2015Z
LANDING: 2300Z FSS T=24, Td=10
NOTES: Ozone instruments were re-installed for this flight.

**6 June 1994 Flight hours 5.1 (Hobbs) Pilot: TLC**
SUMMARY: The "h", "i", "j" L-shaped pattern was flown today. The KA was going to be flying the same pattern, and the Electra was going to be in the same vicinity. In the 2nd portion, different altitudes were flown for flux divergence measurements.
WEATHER: Some cloudiness in the early morning, coupled with ground fog progressing to approx. 50% coverage by mid-afternoon.
TAKEOFF: FSS winds 050/10, alt 29.98, T = 14.1, Td = 11.9
NOTES: During the first part of the flight, one of the switches on the gyros weren't on...after landing, the switch was turned on, ready for immediate takeoff. At approximately 1100, during flight, the alternator fuse blew, so Tim shutoff electrical power and came in. The fuse was replaced, and there was another takeoff at approximately 1215L. Same problem occurred, and the next landing was at approx. 1430L. Additionally, the ozone inlet tube came off sometime during flight, so the slow ozone data may be bad.

**7 June 1994 Flight hours 4.3 (Hobbs) Pilot: TLC**
SUMMARY: Candle Lake runs - the only one of the BOREAS Airforce out there
WEATHER: Windy, warm, blue skies with cirrus to the south.
TAKEOFF: 1440Z FSS Alt 30.06, winds 090/15
LANDING: 1850Z
NOTES: Ozone inlet tube came off sometime during flight yesterday...repaired for today's flight. Before flight, glycol mixed with ethyl alcohol was added to the fast-response ozone instrument. During flight, TLC noted that the fast sensor #1 was over sensitive, but that fast sensor #2 seemed OK. Also prior to flight, there was a calibration done on the fast ozone with the new solution, and there was a calibration on the $CO_2$ instruments with the 3 concentrations.

**7 June 1994 Flight hours 3.4 (Hobbs) Pilot: EJD**
SUMMARY: Candle Lake runs
WEATHER: Very windy, clear, cirrus to the south.
TAKEOFF: 2000Z Alt 30.02 FSS Winds 090/15G20 T=21.
LANDING: 2330Z FSS T=22.6, TD=-1.0
Note: The fast ozone sensors ran out of solution sometime during flight.

**8 June 1994 Flight hours 4.7 (Hobbs) Pilot: TLC**
SUMMARY: Asterisk pattern around Old Jack Pine - first counterclockwise in 15 deg increments, then counterclockwise in 15 deg increments.
WEATHER: On site, initially clear with cirrus aloft, then gradual increasing cloudiness. Winds along the path were approx 10 m/s.
TAKEOFF: 1530Z FSS T=15.5, Td=6.4, Alt 29.99, winds 120/10
LANDING: 1930Z FSS T=18.7, Td=11.3, winds 230/5
NOTES: In-line filter installed on Li-COR 6262 this morning - trying to mitigate pollen problems. $CO_2$ and ozone calibration done prior to flight, and in between flights. No TANS pseudo ranges during flight.

**8 June 1994 Flight hours 2.5 (Hobbs) Pilot: EJD**
SUMMARY: OJP asterisks
WEATHER: Overcast to the south, mostly clear to the north.
TAKEOFF: 2015Z FSS T = 18.8 C, Td = 11.5 C, winds 190/10, Alt 29.97
LANDING: 2230Z FSS T = 18.4 C, Td = 10.2 C, winds 210/5, Alt 29.97
Notes: Solution on fast response ozone sensors ran out during flight.

**10 June 1994 Flight hours 5.6 (Hobbs) Pilot: TLC**
SUMMARY: This flight was an asterisk over the Old Aspen site, and then 5 runs along the Candle Lake transect.
WEATHER: Clear in the morning (0800 or so), some ground haze - then by mid-morning, there was alto-status mixed with cirrus and some small Cu. By mid-afternoon the wind increased, and the stratus and cirrus had dissipated, and small Cu covered about 25-30% of the sky.
TAKEOFF: 1445Z FSS T = 17.3, Td = 7.9 (jumped to 8.3 while he was talking) winds 300/10, Alt 29.98
LANDING: 2030 FSS T = 22.4, Td = 8.1
NOTES: Adj offset on both the fast ozones. Also a $CO_2$ cal done

**10 June 1994 Flight hours 3.3 (Hobbs) Pilot: EJD**
SUMMARY: On this flight, a figure 8 pattern was flown over the Old Jack Pine site.
WEATHER: Mostly clear - Cu hum.
TAKEOFF: 2030Z FSS T = 22.2, Td = 7.8
LANDING: 2355Z FSS T = 23.3, Td = 5.9
Note: On landing, the program had an overflow error message.

**11 June 1994 Flight hours 4.8 (Hobbs) Pilot: TLC**
SUMMARY: The h, i, j "L" pattern was flown, coupled with circles at various altitudes over Old Jack Pine.
WEATHER: Cu building throughout the flight (10% coverage at the beginning, ending with about 40% coverage). Areas of lite precip around the OJP site.
TAKEOFF: 1610Z FSS T = 18.2, Td = 9.5, winds 300/5
LANDING: 2015Z FSS T = 20.8, Td = 9.4, winds 290/5 to 10
NOTES: Original takeoff was at 0900L - TANS didn't come up, so TLC landed and reloaded vectors and rebooted the top board.

**12 June 1994 Flight hours 1.0 (Hobbs) Pilot: EJD**
SUMMARY: Pitch cal
WEATHER: 30-40% coverage of small Cu congestus
TAKEOFF: 1230Z winds 290/5, Alt 29.68 T = 11.7, Td = 9.3 Landing: 1315Z T = 12.8, Td = 9.7
NOTES: Weight = 1397.3 lbs; CG = 101.48 in. No ozone or $CO_2$ for this flight.

**12 June 1994 Flight hours 3.7 (Hobbs) Pilot: EJD**
SUMMARY: The original plan called for Figure 8s over OJP; however, there was bad weather in the area, so EJD landed and discussed an alternate plan. The decision was then to do the Old Aspen site. Figure 8s and 'Ls' were done over that site.
WEATHER: Cu building - clouds and rain over the area - mixed bag of weather
TAKEOFF: 1500Z (1st), 1615Z (2nd) FSS winds 330/5, Alt 29.68
LANDING: 1600Z (1st), 1845Z (2nd) FSS T=17.3, Td=8.6, winds 360/5G10, Alt 29.68
NOTE: ***Gyros were off for whole flight***

**12 June 1994 Flight hours 2.3 (Hobbs) Pilot: TLC**
SUMMARY: Figure eights over Old Jack Pine
WEATHER: Building Cu throughout the flight...no precip for most of the time, some light precip near the end.
TAKEOFF: 1915Z FSS T=17.2, Td=8.6
LANDING: 2100Z
NOTESs: ± 2.5 nm around the tower has similar surface use as the tower -the rest is choppy and dissimilar (TLC in-flight note). Flight was terminated early because the data system 'crashed'.
*****GYROS WERE OFF THE WHOLE FLIGHT*****

**20 July 1994 Flight time 5.1 hr (Hobbs) Pilot: TLC**
SUMMARY: Pre-Test flight, 2 PRO's and 7 Candle Lake transects. Both the Electra and King Air flew the CL transects at the same time. Fast and slow $O_3$ sensors installed after significant improvements between IFC1-2. Now believed to be working.
WEATHER: Lots of rain last few days. Forest fires have reduced visibility to about 5 miles. The wind is from the north @10 kts. At 1600 Cu started to build. During the day buildup continued at a slow but persistent rate to around 50% by the end of the flight.
PROBLEM - Flux gate had compass failed, now removed. Some GPS ground station data lost around noon. The NET did not work this flight due to a bad connection which was repaired after the flight. File 07201834 had an unreadable block. On test flight the gyro 10A fuse blew. It was replaced with a 12A. Does this indicate a future problem?
NOTES: Average site altitude is about 1900 msl. The gyro was cleaned before this flight to remove data "spikes".

**21 July 1994 Flight time 5.1 hours (Hobbs) Pilot: EJD**
SUMMARY: 1 Pitch Cal, 7 Candle Lake transects, 1 Profile. Both the Twin Otter and King Air flew the grid transects at the same time.
WEATHER: Excellent visibility today. No Cu in the morning, built to less than 10% in the afternoon. Wind calm initially, picked up considerably in the afternoon. Turbulence very light in the morning picked up considerably in the afternoon.
PROBLEM - No problems noted during flight. All instruments seemed to work well.

**21 July 1994 Flight time 3.8 hours (Hobbs) Pilot: TLC**
SUMMARY: 2-PRO's, 2 complete and 2 short Candle Lake transects. The last CL transect was flown with the TO. Flight direction was to west. At Candle lake, the flight speed was reduced from 120 kts to 110 kts. FE also flew the transect but ahead of FL & FT. This was a "golden day" with 16 flights!
WEATHER: Clear sky all day! Winds low and from 030
PROBLEM - Data system crashed caused early mission termination.
NOTES: Since the winds are down the transect and lots of flight missions were flown, this may be a good day for "lake effects" boundary layer research.

**22 July 1994 Flight time 1.7 hours (Hobbs) Pilot: EJD**
SUMMARY: 2 Pitch Cals, 1 Candle Lake transect. Late evening, not much activity.
WEATHER: Clear over YPA, high clouds over CL transect. Very little turbulence on CL run.
PROBLEM - No problems noted during flight. All instruments seemed to work well.

**23 July 1994 Flight time 4.7 hours (Hobbs) Pilot: TLC**
SUMMARY: 2-PRO's and 6 Candle Lake transects. The last CL transect was flown with the FK which operated at 200 AGL and 3500 MSL. FT also flew the CL transect during transition from SS-OA to SS-OBS & OJP.
WEATHER: Flight started with clear skies but small Cu developed from delta to alpha. By the end of the flight, the Cu was 60% at delta and 10% at alpha. The wind was 330 at ?
PROBLEM - The O3 sensors were removed for this and all future flights. The last two flights should have had good $O_3$ data.

**23 July 1994 Flight time 2.6 hours (Hobbs) Pilot: EJD**
SUMMARY: 2-PRO's and OJP site specific.
WEATHER: Flight started with cloudy skies > 50% cloud cover. Turbulence was extremely rough. Terminated flight early due to extreme turbulence.

**24 July 1994 Flight time 5.2 hours (Hobbs) Pilot: TLC**
SUMMARY: 2-PRO's and 9 FLX L's under clear sky & light North winds. The FT& FK flew the "Grid" during this flight.
WEATHER: Clear all day! Winds light and from the north.

**24 July 1994 Flight time 4.5 hours (Hobbs) Pilot: EJD**
SUMMARY: 2-PRO's and 8 FLX L's under clear sky & light North winds. The FT flew the L's at the same time as N3R.
WEATHER: Clear all day! Winds light and from the north. Some turbulence early in flight, decaying toward the end.

**25 July 1994 Flight time 6.6 hours (Hobbs) Pilot: TLC**
SUMMARY: Golden day #2. 2-PRO's and 9 CL FLX's under clear sky & calm winds. The FT worked site specifics while FK did CL at 200 AGL & 3500 MSL. There are two flights where FT and FK were on the same transect at close to the same time.
WEATHER: Clear all day! Winds very light and from the north. Winds a little stronger to the east.
PROBLEM - Channel 4 power controller, which powers the gyros, blew a second fuse. We are now running with a 14A fuse in this channel. Power channels2 & 3 are not working correctly. They were disabled and bypassed with a switch. The dew point has shown some problems on previous flights. The mirror was cleaned before this flight. Audio flight notes were lost during last half of flight.

**26 July 1994 Flight time 4.9 hours (Hobbs) Pilot: EJD**
SUMMARY: Golden day #3. 1-Pitch cal, 1 PRO, and a bunch of OAS FLX's under clear sky & calm winds.
WEATHER: Clear all morning! Winds very light and from the southwest.
PROBLEM - No equipment problems noted. All sensors appeared to be working well.

**26 July 1994 Flight time 4.5 hours (Hobbs) Pilot: TLC**
SUMMARY: 2-PRO's and 2 OJP asterisk under clear sky & calm winds.
WEATHER: Clear all day! Winds very light. Thin smoke/haze layer at ~8000.

**27 July 1994 Flight time 1.0 hour (Hobbs) Pilot: EJD**
SUMMARY: 1 Takeoff file, 1 Pitch cal, 1 river climb, 1 touch & go.
WEATHER: Haze layer at 4000' during Pitch cal. Clear otherwise. PROBLEM - No equipment problems noted. All sensors appeared to be working well.

**27 July 1994 Flight time 5.9 hours (Hobbs) Pilot: TLC**
SUMMARY: 2-PRO's and 5 FLX E-W grids under clear sky & low southerly winds.
WEATHER: Clear all day however there is a lot of smoke and haze! Winds light.
PROBLEM - MFP clock set one day behind. All data files corrected. The last file, which included a PRO, TXI and STC, and its associated markers were lost.
NOTES: NSA is now the "hot" site; other aircraft operating in N. The IRGA was cleaned before the flight.

**28 July 1994 Flight time 5.8 hours (Hobbs) Pilot: EJD**
SUMMARY: 2 PRO's and 8 Candle Lake flux runs under clear sky initially, rapid buildup of Cu to approx 40% for last 2 FLX runs. WEATHER: Clear sky for first 4 hours, last 2 hours rapid buildup of approx40% Cu and a thunderstorm near d on last FLX run.
**29 July 1994 Flight time 4.1 hours (Hobbs) Pilot: TLC**
SUMMARY: 2 PRO's and 5 CL FLX under unsettled (variable cloud and some rain) conditions.
WEATHER: Front passing through with associated unsettled conditions. Low small Cu (2000-2500) generated by overnight rain. Stratus at 12000. Winds are calm.

**29 July 1994 Flight time Pilot: EJD**
SUMMARY: 17 legs of Fig 8 pattern at Old Aspen
WEATHER:

**30 July 1994 Flight time Pilot: EJD**
SUMMARY: 8 Candle Lake Flux transects

**30 August 1994Flight hours 2.1 (Hobbs)**
SUMMARY: Shakedown flight - some problems encountered, i.e. no angles on first flight, but after rebooting the top card and reloading the antennae vectors, everything with respect to the TANS was up and operating correctly. On the last attempt, however, the gyros were not on.
WEATHER: Mostly cloudy all day, with intermittent, moderate rain. Conditions were not conducive for any good Candle Lake transects, or any site specific work.
NOTES: The Tp and Th pots were adjusted today, because the Tp was offscale low. The Th pots were accidentally adjusted (thinking they were the Tp's), but they were turned back and both the Tp and the Th look good now.

**31 August 1994 Flight time 5.8 hours (Hobbs)**
SUMMARY: Candle Lake transects
WEATHER: Clear in the morning (up to about 10 a.m. local), then small Cu for the remainder of the day (coverage about 25%)

**1 September 1994 Flight time 6.2 hours (Hobbs)**
SUMMARY: Candle Lake transects.
WEATHER: Clear in the morning, with Cu building around noon. Coverage was no more than 25%. By 1600L, most of the Cu had dissipated - coverage reduced to about 10% - more to the North. On the transects there was Cu and haze.

**3 September, 1994 Flight time 4.4 hours (Hobbs)**
SUMMARY: Buttonhole patterns over Old Jack Pine. Ground tracks of 030 and 210 deg.
WEATHER: Overcast on site for whole flight. Moderate to strong crosswind.

**5 September 1994 Flight time 5.0 hours (Hobbs)**
SUMMARY: Buttonhole patterns at Old Jack Pine and Black Spruce.
WEATHER: Clear and calm for takeoff, then around noon the clouds began to form and the winds picked up significantly. Along the flight path, it was turbulent and windy.
NOTE: Ozone filter came off sometime during flight

**6 September 1994 Flight time 6.2 hours (Hobbs)**
SUMMARY: Candle Lake transects
WEATHER: Clear and calm on takeoff. Winds increased and changed directions in the early afternoon. Sky was clear all day with the exception of a few small Cu to the northeast (less than 5% coverage). There was a gradual wind shift at P.A. throughout the day.
NOTES: Ozone filter came off sometime during flight (again).

**7 September 1994 Flight A Flight time 4.4 hours (Hobbs)**
SUMMARY: 18 runs by OJP
WEATHER: Overcast in the morning with cirrus, clearing by mid-morning but with some cirrus still.

**7 September 1994 Flight B Flight time 3.5 (Hobbs)**
SUMMARY: Buttonhole pattern around the Old Aspen site.
WEATHER: Some thin high cirrus, but basically warm and clear. Winds were 110-120 at 10 most of the day (at P.A.)

**8 September 1994 Flight A Flight time 4.4 hours (Hobbs)**
SUMMARY: Grid pattern.
WEATHER: Clear, dry, warm, no wind.

**8 September 1994 Flight B**
SUMMARY: Grid patterns
WEATHER: Clear, dry, warm, almost no wind

**9 September 1994 Flight time 3.4 hours (Hobbs)**
SUMMARY: Buttonhole patterns over Old Jack Pine
WEATHER: Overcast with cirrus, slight wind, warm and humid

**11 September 1994 Flight time 5.4 hours (Hobbs)**
SUMMARY: Candle Lake transects
WEATHER: Started out cloudy, then cleared in the P.A. area. Cool day. EJD said the Candle Lake transect was overcast.
NOTES: Time of flight needs fixing. When the data system was started, the computer clock showed 1536 and the GPS showed 1618.

**12 September 1994 Flight time 4.8 hours (Hobbs)**
SUMMARY: Old Jack Pine and Old Aspen buttonhole patterns
WEATHER: The day started out overcast and rainy, but around 1030L, it started to clear; then Cu started to form around noon. Cloud cover remained around 25% in the P.A. area.
NOTES: Computer time and GPS time were different by about 45 min. (GPS was 1738, computer was 1654.

**13 September 1994 Flight time 5.0 hours (Hobbs)**
SUMMARY: Site specific work over Old Black Spruce to coordinate with Larry Mahrt. Then over to Old Jack Pine to allow Canadian TV to film some flybys.
WEATHER: Clear in the P.A. area until noon, then cirrus. Over the OBS it was clear except for some cirrus, and over Old Jack Pine, basically clear conditions. NOTE: TIMES ARE WRONG!!

**15 September 1994 Flight time 3.4 hours (Hobbs)**
SUMMARY: IC with the Twin Otter over the Old Aspen site, then a couple of Candle Lake transects, and a pitch cal.
WEATHER: Started out with some clouds, gradually cleared. By 1430 (local) the sky had less than 5% coverage of small Cu, with some cirrus.

# 7. Data Description

## 7.1 Spatial Characteristics

### 7.1.1 Spatial Coverage

Candle Lake transects covered an approximate 100-km transect; one pass by a tower was approximately 12 km; a grid leg was approximately 15 km; the "L" pattern ranged from 100 to 200 km.

The Long-EZ aircraft covered sites in the SSA. The North American Datum of 1983 (NAD83) corner coordinates of the SSA are:

| | Longitude | Latitude |
|---|---|---|
| Northwest | 106.228° W | 54.321° N |
| Northeast | 104.237° W | 54.225° N |
| Southwest | 106.321° W | 53.515° N |
| Southeast | 104.368° W | 53.420° N |

The tower sites in the SSA include:

| Site | Longitude | Latitude | BOREAS X | BOREAS Y |
|---|---|---|---|---|
| OBS | 105.11779° W | 53.98717° N | 385.012 | 348.646 |
| OJP | 104.69203° W | 53.91634° N | 413.526 | 343.226 |
| Young Jack Pine (YJP) | 104.64529° W | 53.87581° N | 416.988 | 339.008 |
| Fen | 104.61798° W | 53.80206° N | 419.527 | 330.991 |
| OA | 106.19779° W | 53.62889° N | 317.198 | 303.403 |

### 7.1.2 Spatial Coverage Map

None.

### 7.1.3 Spatial Resolution

The spatial resolution of the original data used in the flux computations is a function of the aircraft speed (50 m/s) and the digital recording rate (40 Hz). This translates to a basic sampling resolution of approximately 1 m for the Long-EZ. However, there is significant natural geophysical variability associated with any turbulence measurement. As a result, statistically significant covariance flux measurement requires space- or time-averaging. The reported data values represent 3-km averages. The basis for the utility of this short average is the Long-EZ's low flight altitude and fast-response data system. The size of flux-transporting turbulence structure decreases (i.e., frequency increases) as the measurement altitude is reduced. This tends to reduce the importance of intermittency, which adversely affects measurements made at higher altitudes.

### 7.1.4 Projection

Not applicable.

### 7.1.5 Grid Description

Not applicable.

### 7.2 Temporal Characteristics

These data were collected during the BOREAS IFCs in 1994. The range of dates is from 25-May to 15-Sep-1994.

### 7.2.1 Temporal Coverage

There were typically two or three flights per day, with 4-5 hour duration each. The days during which data were collected are:

| Flight Dates | Flight Dates | Flight Dates |
|---|---|---|
| 25-May-1994 | 20-Jul-1994 | 31-Aug-1994 |
| 26-May-1994 | 21-Jul-1994 | |
| 27-May-1994 | 22-Jul-1994 | 01-Sep-1994 |
| 29-May-1994 | 23-Jul-1994 | 03-Sep-1994 |
| 31-May-1994 | 24-Jul-1994 | 05-Sep-1994 |
| | 25-Jul-1994 | 06-Sep-1994 |
| 01-Jun-1994 | 26-Jul-1994 | 07-Sep-1994 |
| 04-Jun-1994 | 27-Jul-1994 | 08-Sep-1994 |
| 06-Jun-1994 | 28-Jul-1994 | 09-Sep-1994 |
| 07-Jun-1994 | 29-Jul-1994 | 11-Sep-1994 |
| 08-Jun-1994 | 30-Jul-1994 | 12-Sep-1994 |
| 10-Jun-1994 | | 13-Sep-1994 |
| 11-Jun-1994 | | 15-Sep-1994 |

### 7.2.2 Temporal Coverage Map

None.

### 7.2.3 Temporal Resolution

The aircraft data were digitized at 200 Hz to allow an oversampling factor of five before recording at 40 Hz.

## 7.3 Data Characteristics

### 7.3.1 Parameter/Variable

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

```
         Column Name
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SPATIAL_COVERAGE
RUN_START_DATE
RUN_START_TIME
RUN_END_DATE
RUN_END_TIME
FLUX_MISSION_DESIGNATOR
FLUX_MISSION_NUM
FLUX_PASS_NUM
FLUX_SEGMENT_NUM
START_LATITUDE
START_LONGITUDE
END_LATITUDE
END_LONGITUDE
START_BOREAS_X
START_BOREAS_Y
END_BOREAS_X
END_BOREAS_Y
HEADING
MEAN_PRESS_ALTITUDE
MEAN_RADAR_ALTITUDE
MEAN_WIND_DIR
MEAN_WIND_SPEED
MEAN_AIR_TEMP
MEAN_POTNTL_TEMP
MEAN_H2O_MIX_RATIO
MEAN_U_COMPNT_WIND_VELOC
MEAN_V_COMPNT_WIND_VELOC
MEAN_STATIC_PRESS
MEAN_SURF_RAD_TEMP
MEAN_DOWN_TOTAL_RAD
MEAN_UP_TOTAL_RAD
MEAN_DOWN_LONGWAVE_RAD
MEAN_UP_LONGWAVE_RAD
MEAN_NET_RAD
MEAN_UP_PPFD
MEAN_DOWN_PPFD
MEAN_AUX_RAD
MEAN_GREEN_INDEX
MEAN_CO2_CONC
MEAN_O3_CONC
```

MEAN_CH4_CONC
MEAN_SAT_SIM_CH1
MEAN_SAT_SIM_CH2
MEAN_SAT_SIM_CH3
MEAN_SAT_SIM_CH4
SDEV_AIR_TEMP
SDEV_POTNTL_TEMP
SDEV_H2O_MIX_RATIO
SDEV_U_COMPNT_WIND_VELOC
SDEV_V_COMPNT_WIND_VELOC
SDEV_STATIC_PRESS
SDEV_SURF_RAD_TEMP
SDEV_DOWN_TOTAL_RAD
SDEV_UP_TOTAL_RAD
SDEV_DOWN_LONGWAVE_RAD
SDEV_UP_LONGWAVE_RAD
SDEV_NET_RAD
SDEV_UP_PPFD
SDEV_DOWN_PPFD
SDEV_AUX_RAD
SDEV_GREEN_INDEX
SDEV_CO2_CONC
SDEV_O3_CONC
SDEV_CH4_CONC
SDEV_SAT_SIM_CH1
SDEV_SAT_SIM_CH2
SDEV_SAT_SIM_CH3
SDEV_SAT_SIM_CH4
TREND_AIR_TEMP
TREND_POTNTL_TEMP
TREND_H2O_MIX_RATIO
TREND_U_COMPNT_WIND_VELOC
TREND_V_COMPNT_WIND_VELOC
TREND_STATIC_PRESS
TREND_SURF_RAD_TEMP
TREND_DOWN_TOTAL_RAD
TREND_UP_TOTAL_RAD
TREND_DOWN_LONGWAVE_RAD
TREND_UP_LONGWAVE_RAD
TREND_GREEN_INDEX
TREND_CO2_CONC
TREND_O3_CONC
TREND_CH4_CONC
SDEV_VERT_GUST_RAW
SDEV_U_COMPNT_WIND_VELOC_RAW
SDEV_V_COMPNT_WIND_VELOC_RAW
SDEV_ALONG_WIND_RAW
SDEV_CROSS_WIND_RAW
SDEV_POTNTL_TEMP_RAW
SDEV_H2O_MIX_RATIO_RAW
SDEV_CO2_MIX_RATIO_RAW
SDEV_O3_CONC_RAW
SDEV_CH4_CONC_RAW
SKEW_VERT_GUST_RAW

SKEW_U_COMPNT_WIND_VELOC_RAW
SKEW_V_COMPNT_WIND_VELOC_RAW
SKEW_ALONG_WIND_RAW
SKEW_CROSS_WIND_RAW
SKEW_POTNTL_TEMP_RAW
SKEW_H2O_MIX_RATIO_RAW
SKEW_CO2_MIX_RATIO
SKEW_O3_CONC_RAW
SKEW_CH4_CONC_RAW
KURT_VERT_GUST_RAW
KURT_U_COMPNT_WIND_VELOC_RAW
KURT_V_COMPNT_WIND_VELOC_RAW
KURT_ALONG_WIND_RAW
KURT_CROSS_WIND_RAW
KURT_POTNTL_TEMP_RAW
KURT_H2O_MIX_RATIO_RAW
KURT_CO2_MIX_RATIO_RAW
KURT_O3_CONC_RAW
KURT_CH4_CONC_RAW
CORC_VERT_U_WIND_COMPNT_RAW
CORC_VERT_V_WIND_COMPNT_RAW
CORC_VERT_ALONG_WIND_RAW
CORC_VERT_CROSS_WIND_RAW
CORC_VERT_POTNTL_TEMP_RAW
CORC_VERT_H2O_MIX_RATIO_RAW
CORC_VERT_CO2_MIX_RATIO_RAW
CORC_VERT_O3_CONC_RAW
CORC_VERT_CH4_CONC_RAW
CORC_POTNTL_H2O_MIX_RATIO_RAW
MMNTM_FLUX_V_WIND_COMPNT_RAW
MMNTM_FLUX_U_WIND_COMPNT_RAW
MMNTM_FLUX_ALONG_MEAN_WIND_RAW
MMNTM_FLUX_CROSS_MEAN_WIND_RAW
SENSIBLE_HEAT_FLUX_RAW
LATENT_HEAT_FLUX_RAW
CO2_FLUX_RAW
O3_FLUX_RAW
O3_DEPOSITION_VELOC_RAW
CH4_FLUX_RAW
AIR_DENSITY_CONSTANT
SPECIFIC_HEAT_CONSTANT
LATENT_HEAT_VAP_CONSTANT
DRY_AIR_GAS_CONSTANT
SDEV_VERT_GUST_DET
SDEV_U_COMPNT_WIND_VELOC_DET
SDEV_V_COMPNT_WIND_VELOC_DET
SDEV_ALONG_WIND_DET
SDEV_CROSS_WIND_DET
SDEV_POTNTL_TEMP_DET
SDEV_H2O_MIX_RATIO_DET
SDEV_CO2_MIX_RATIO
SDEV_O3_CONC_DET
SDEV_CH4_CONC_DET
SKEW_VERT_GUST_DET

SKEW_U_COMPNT_WIND_VELOC_DET
SKEW_V_COMPNT_WIND_VELOC_DET
SKEW_ALONG_WIND_DET
SKEW_CROSS_WIND_DET
SKEW_POTNTL_TEMP_DET
SKEW_H2O_MIX_RATIO_DET
SKEW_CO2_MIX_RATIO_DET
SKEW_O3_CONC_DET
SKEW_CH4_CONC_DET
KURT_VERT_GUST_DET
KURT_U_COMPNT_WIND_VELOC_DET
KURT_V_COMPNT_WIND_VELOC_DET
KURT_ALONG_WIND_DET
KURT_CROSS_WIND_DET
KURT_POTNTL_TEMP_DET
KURT_H2O_MIX_RATIO_DET
KURT_CO2_MIX_RATIO_DET
KURT_O3_CONC_DET
KURT_CH4_CONC_DET
CORC_VERT_U_WIND_COMPNT_DET
CORC_VERT_V_WIND_COMPNT_DET
CORC_VERT_ALONG_WIND_DET
CORC_VERT_CROSS_WIND_DET
CORC_VERT_POTNTL_TEMP_DET
CORC_VERT_H2O_MIX_RATIO_DET
CORC_VERT_CO2_MIX_RATIO_DET
CORC_VERT_O3_CONC_DET
CORC_VERT_CH4_CONC_DET
CORC_POTNTL_H2O_MIX_RATIO_DET
MMNTM_FLUX_U_WIND_COMPNT_DET
MMNTM_FLUX_V_WIND_COMPNT_DET
MMNTM_FLUX_ALONG_MEAN_WIND_DET
MMNTM_FLUX_CROSS_MEAN_WIND_DET
SENSIBLE_HEAT_FLUX_DET
LATENT_HEAT_FLUX_DET
CO2_FLUX_DET
O3_FLUX_DET
O3_DEPOSITION_VELOC_DET
CH4_FLUX_DET
CRTFCN_CODE
REVISION_DATE

### 7.3.2 Variable Description/Definition

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

| Column Name | Description |
|---|---|
| SPATIAL_COVERAGE | The general term used to denote the spatial area over which the data were collected. |
| RUN_START_DATE | The date in GMT at the beginning of the segment (or pass if not segmented) in the form DD-MON-YY. |
| RUN_START_TIME | The time in GMT at the beginning of the segment (or pass if not segmented). |

| | |
|---|---|
| RUN_END_DATE | The date in GMT at the end of the segment (or pass if not segmented) in the form DD-MON-YY. |
| RUN_END_TIME | The time in GMT at the end of the segment (or pass if not segmented). |
| FLUX_MISSION_DESIGNATOR | The two-letter mission identifier used to identify the type of mission being flown, where GS or GN=grids and stacks, CS=Candle Lake runs, TS or TN=site-specific runs, RT=transects, LS or LN=mini- or meso-transects, PS or PN=Budget Box pattern, HS or HN=stacks and tees, FS or FN=flights of two for intercomparison, ZS=low-level routes, and XX=not standard. |
| FLUX_MISSION_NUM | The sequential number for all missions flown on a given day starting at 1. |
| FLUX_PASS_NUM | The sequential pass number within a mission starting at 1. |
| FLUX_SEGMENT_NUM | The segment number within the current pass starting at 1 or given as 0 if pass is not segmented. |
| START_LATITUDE | The NAD83 based latitude coordinate at the start of the measurement set. |
| START_LONGITUDE | The NAD83 based longitude coordinate at the start of the measurement set. |
| END_LATITUDE | The NAD83 based latitude coordinate at the end of the measurement set. |
| END_LONGITUDE | The NAD83 based longitude coordinate at the end of the measurement set. |
| START_BOREAS_X | The x component of the BOREAS grid coordinate at the start of the measurement set. |
| START_BOREAS_Y | The y component of the BOREAS grid coordinate at the start of the measurement set. |
| END_BOREAS_X | The x component of the BOREAS grid coordinate at the end of the measurement set. |
| END_BOREAS_Y | The y component of the BOREAS grid coordinate at the end of the measurement set. |
| HEADING | The aircraft heading. |
| MEAN_PRESS_ALTITUDE | The mean pressure altitude. |
| MEAN_RADAR_ALTITUDE | The mean radar altitude. |
| MEAN_WIND_DIR | The mean direction from which the wind was traveling, increasing in a clockwise direction from the north for the given time over the period defined by the start and end dates. |
| MEAN_WIND_SPEED | The mean wind speed for the given time over the period defined by the start and end dates. |
| MEAN_AIR_TEMP | The mean air temperature. |
| MEAN_POTNTL_TEMP | The mean potential temperature. |
| MEAN_H2O_MIX_RATIO | The mean water vapor mixing ratio. |
| MEAN_U_COMPNT_WIND_VELOC | The mean westerly vector component of the wind speed and wind direction. |
| MEAN_V_COMPNT_WIND_VELOC | The mean southerly vector component of the wind speed and wind direction. |
| MEAN_STATIC_PRESS | The mean static pressure. |
| MEAN_SURF_RAD_TEMP | The mean surface radiative temperature. |
| MEAN_DOWN_TOTAL_RAD | The mean downwelling total radiation. |

| | |
|---|---|
| MEAN_UP_TOTAL_RAD | The mean upwelling total radiation. |
| MEAN_DOWN_LONGWAVE_RAD | The mean downward longwave radiation. |
| MEAN_UP_LONGWAVE_RAD | The mean upwelling longwave radiation. |
| MEAN_NET_RAD | The mean net radiation. |
| MEAN_UP_PPFD | The mean upward photosynthetic photon flux density. |
| MEAN_DOWN_PPFD | The mean downward photosynthetic photon flux density. |
| MEAN_AUX_RAD | The mean measurement from the auxiliary radiation sensor. |
| MEAN_GREEN_INDEX | The mean greenness index. |
| MEAN_CO2_CONC | The mean carbon dioxide concentration. |
| MEAN_O3_CONC | The mean ozone concentration. |
| MEAN_CH4_CONC | The mean methane concentration. |
| MEAN_SAT_SIM_CH1 | The mean channel 1 satellite simulator. |
| MEAN_SAT_SIM_CH2 | The mean channel 2 satellite simulator. |
| MEAN_SAT_SIM_CH3 | The mean channel 3 satellite simulator. |
| MEAN_SAT_SIM_CH4 | The mean channel 4 satellite simulator. |
| SDEV_AIR_TEMP | The standard deviation of the air temperature. |
| SDEV_POTNTL_TEMP | The standard deviation of potential temperature. |
| SDEV_H2O_MIX_RATIO | The standard deviation of the water vapor mixing ratio. |
| SDEV_U_COMPNT_WIND_VELOC | The standard deviation of the westerly vector component of the wind speed and wind direction. |
| SDEV_V_COMPNT_WIND_VELOC | The standard deviation of the southerly vector component of the wind speed and wind direction. |
| SDEV_STATIC_PRESS | The standard deviation of the static pressure. |
| SDEV_SURF_RAD_TEMP | The standard deviation of the surface radiative temperature. |
| SDEV_DOWN_TOTAL_RAD | The standard deviation of downwelling total radiation. |
| SDEV_UP_TOTAL_RAD | The standard deviation of upwelling total radiation. |
| SDEV_DOWN_LONGWAVE_RAD | The standard deviation of the downward longwave radiation. |
| SDEV_UP_LONGWAVE_RAD | The standard deviation of upwelling longwave radiation. |
| SDEV_NET_RAD | The standard deviation of the mean net radiation. |
| SDEV_UP_PPFD | The standard deviation of the upward photosynthetic photon flux density. |
| SDEV_DOWN_PPFD | The standard deviation of the downward photosynthetic photon flux density. |
| SDEV_AUX_RAD | The standard deviation of the measurements from the auxiliary radiation sensor. |
| SDEV_GREEN_INDEX | The standard deviation of greenness index. |
| SDEV_CO2_CONC | The standard deviation of the CO2 concentration. |
| SDEV_O3_CONC | The standard deviation of the ozone concentration. |
| SDEV_CH4_CONC | The standard deviation of CH4 concentration. |
| SDEV_SAT_SIM_CH1 | The standard deviation of the channel 1 satellite simulator values. |
| SDEV_SAT_SIM_CH2 | The standard deviation of channel 2 satellite simulator values. |
| SDEV_SAT_SIM_CH3 | The standard deviation of channel 3 satellite |

| | |
|---|---|
| | simulator values. |
| SDEV_SAT_SIM_CH4 | The standard deviation of channel 4 satellite simulator values. |
| TREND_AIR_TEMP | The trend in air temperature. |
| TREND_POTNTL_TEMP | The trend in potential temperature. |
| TREND_H2O_MIX_RATIO | The trend in water vapor mixing ratio. |
| TREND_U_COMPNT_WIND_VELOC | The trend in the westerly vector component of the wind speed and wind direction. |
| TREND_V_COMPNT_WIND_VELOC | The trend in the southerly vector component of the wind speed and wind direction. |
| TREND_STATIC_PRESS | The trend in static pressure. |
| TREND_SURF_RAD_TEMP | The trend in surface radiative temperature. |
| TREND_DOWN_TOTAL_RAD | The trend in the downwelling total radiation. |
| TREND_UP_TOTAL_RAD | The trend in the upwelling total radiation. |
| TREND_DOWN_LONGWAVE_RAD | The trend in the downwelling longwave radiation. |
| TREND_UP_LONGWAVE_RAD | The trend in the upwelling longwave radiation. |
| TREND_GREEN_INDEX | The trend in the greenness index. |
| TREND_CO2_CONC | The trend in the carbon dioxide concentration. |
| TREND_O3_CONC | The trend in the ozone concentration. |
| TREND_CH4_CONC | The trend in the methane concentration. |
| SDEV_VERT_GUST_RAW | The standard deviation of the raw vertical gust. |
| SDEV_U_COMPNT_WIND_VELOC_RAW | The standard deviation of the raw westerly wind component. |
| SDEV_V_COMPNT_WIND_VELOC_RAW | The standard deviation of the raw southerly wind component. |
| SDEV_ALONG_WIND_RAW | The standard deviation of the raw along wind component. |
| SDEV_CROSS_WIND_RAW | The standard deviation of the raw cross wind component. |
| SDEV_POTNTL_TEMP_RAW | The standard deviation of the raw potential temperature. |
| SDEV_H2O_MIX_RATIO_RAW | The standard deviation of the raw water vapor mixing ratio. |
| SDEV_CO2_MIX_RATIO_RAW | The standard deviation of the raw carbon dioxide mixing ratio. |
| SDEV_O3_CONC_RAW | The standard deviation of the raw ozone concentration. |
| SDEV_CH4_CONC_RAW | The standard deviation of the raw methane concentration. |
| SKEW_VERT_GUST_RAW | The skewness of the raw vertical gust. |
| SKEW_U_COMPNT_WIND_VELOC_RAW | The skewness of the raw westerly wind component. |
| SKEW_V_COMPNT_WIND_VELOC_RAW | The skewness of the raw southerly wind component. |
| SKEW_ALONG_WIND_RAW | The skewness of the raw along wind component. |
| SKEW_CROSS_WIND_RAW | The skewness of the raw cross wind component. |
| SKEW_POTNTL_TEMP_RAW | The skewness of the raw potential temperature. |
| SKEW_H2O_MIX_RATIO_RAW | The skewness of the raw water vapor mixing ratio. |
| SKEW_CO2_MIX_RATIO | The skewness of the raw carbon dioxide mixing ratio. |
| SKEW_O3_CONC_RAW | The skewness of the raw ozone concentration. |
| SKEW_CH4_CONC_RAW | The skewness of the raw methane concentration. |
| KURT_VERT_GUST_RAW | The kurtosis of the raw vertical gust. |
| KURT_U_COMPNT_WIND_VELOC_RAW | The kurtosis of the raw westerly wind component. |

| | |
|---|---|
| KURT_V_COMPNT_WIND_VELOC_RAW | The kurtosis of the raw southerly wind component. |
| KURT_ALONG_WIND_RAW | The kurtosis of the raw along wind component. |
| KURT_CROSS_WIND_RAW | The kurtosis of the raw cross wind component. |
| KURT_POTNTL_TEMP_RAW | The kurtosis of the raw potential temperature. |
| KURT_H2O_MIX_RATIO_RAW | The kurtosis of the raw water vapor mixing ratio. |
| KURT_CO2_MIX_RATIO_RAW | The kurtosis of the raw carbon dioxide mixing ratio. |
| KURT_O3_CONC_RAW | The kurtosis of the raw ozone concentration. |
| KURT_CH4_CONC_RAW | The kurtosis of the raw methane concentration. |
| CORC_VERT_U_WIND_COMPNT_RAW | The correlation coefficient of the raw vertical gust/westerly wind component pair. |
| CORC_VERT_V_WIND_COMPNT_RAW | The correlation coefficient of the raw vertical gust/southerly wind component pair. |
| CORC_VERT_ALONG_WIND_RAW | The correlation coefficient of the raw vertical gust/along wind component pair. |
| CORC_VERT_CROSS_WIND_RAW | The correlation coefficient of the raw vertical gust/cross wind component pair. |
| CORC_VERT_POTNTL_TEMP_RAW | The correlation coefficient of the raw vertical gust/potential temperature pair. |
| CORC_VERT_H2O_MIX_RATIO_RAW | The correlation coefficient of the raw vertical gust/water vapor mixing ratio pair. |
| CORC_VERT_CO2_MIX_RATIO_RAW | The correlation coefficient of the raw vertical gust/carbon dioxide mixing ratio pair. |
| CORC_VERT_O3_CONC_RAW | The correlation coefficient of the raw vertical gust/ozone concentration pair. |
| CORC_VERT_CH4_CONC_RAW | The correlation coefficient of the vertical gust /methane concentration pair. |
| CORC_POTNTL_H2O_MIX_RATIO_RAW | The correlation coefficient of the raw potential temperature/water vapor mixing ratio pair. |
| MMNTM_FLUX_V_WIND_COMPNT_RAW | The momentum flux using the raw southerly wind component. |
| MMNTM_FLUX_U_WIND_COMPNT_RAW | The momentum flux using the raw westerly wind component. |
| MMNTM_FLUX_ALONG_MEAN_WIND_RAW | The momentum flux using the raw along mean wind component. |
| MMNTM_FLUX_CROSS_MEAN_WIND_RAW | The momentum flux using the raw across mean wind component. |
| SENSIBLE_HEAT_FLUX_RAW | The raw sensible heat flux. |
| LATENT_HEAT_FLUX_RAW | The raw latent heat flux. |
| CO2_FLUX_RAW | The raw carbon dioxide flux. |
| O3_FLUX_RAW | The raw ozone flux. |
| O3_DEPOSITION_VELOC_RAW | The raw ozone deposition velocity. |
| CH4_FLUX_RAW | The raw methane flux. |
| AIR_DENSITY_CONSTANT | The constant used for air density in the flux calculations. |
| SPECIFIC_HEAT_CONSTANT | The constant used for specific heat at constant pressure in the flux calculations. |
| LATENT_HEAT_VAP_CONSTANT | The constant used for latent heat of vaporization in the flux calculations. |
| DRY_AIR_GAS_CONSTANT | The dry air gas constant used in the flux calculations. |
| SDEV_VERT_GUST_DET | The standard deviation of the detrended vertical |

| | |
|---|---|
| | gust. |
| SDEV_U_COMPNT_WIND_VELOC_DET | The standard deviation of the detrended westerly wind component. |
| SDEV_V_COMPNT_WIND_VELOC_DET | The standard deviation of the detrended southerly wind component. |
| SDEV_ALONG_WIND_DET | The standard deviation of the detrended along wind component. |
| SDEV_CROSS_WIND_DET | The standard deviation of the detrended cross wind component. |
| SDEV_POTNTL_TEMP_DET | The standard deviation of the detrended potential temperature. |
| SDEV_H2O_MIX_RATIO_DET | The standard deviation of the detrended water vapor mixing ratio. |
| SDEV_CO2_MIX_RATIO | The standard deviation of the detrended carbon dioxide mixing ratio. |
| SDEV_O3_CONC_DET | The standard deviation of the detrended ozone concentration. |
| SDEV_CH4_CONC_DET | The standard deviation of the detrended methane concentration. |
| SKEW_VERT_GUST_DET | The skewness of the detrended vertical gust. |
| SKEW_U_COMPNT_WIND_VELOC_DET | The skewness of the detrended westerly wind component. |
| SKEW_V_COMPNT_WIND_VELOC_DET | The skewness of the detrended southerly wind component. |
| SKEW_ALONG_WIND_DET | The skewness of the detrended along wind component. |
| SKEW_CROSS_WIND_DET | The skewness of the detrended cross wind component. |
| SKEW_POTNTL_TEMP_DET | The skewness of the detrended potential temperature. |
| SKEW_H2O_MIX_RATIO_DET | The skewness of the detrended water vapor mixing ratio. |
| SKEW_CO2_MIX_RATIO_DET | The skewness of the detrended carbon dioxide mixing ratio. |
| SKEW_O3_CONC_DET | The skewness of the detrended ozone concentration. |
| SKEW_CH4_CONC_DET | The skewness of the detrended methane concentration. |
| KURT_VERT_GUST_DET | The kurtosis of the detrended vertical gust. |
| KURT_U_COMPNT_WIND_VELOC_DET | The kurtosis of the detrended westerly wind component. |
| KURT_V_COMPNT_WIND_VELOC_DET | The kurtosis of the detrended southerly wind component. |
| KURT_ALONG_WIND_DET | The kurtosis of the detrended along wind component. |
| KURT_CROSS_WIND_DET | The kurtosis of the detrended cross wind component. |
| KURT_POTNTL_TEMP_DET | The kurtosis of the detrended potential temperature. |
| KURT_H2O_MIX_RATIO_DET | The kurtosis of the detrended water vapor mixing ratio. |
| KURT_CO2_MIX_RATIO_DET | The kurtosis of the detrended carbon dioxide mixing ratio. |
| KURT_O3_CONC_DET | The kurtosis of the detrended ozone |

| | |
|---|---|
| | concentration. |
| KURT_CH4_CONC_DET | The kurtosis of the detrended methane concentration. |
| CORC_VERT_U_WIND_COMPNT_DET | The correlation coefficient of the detrended vertical gust/westerly wind component pair. |
| CORC_VERT_V_WIND_COMPNT_DET | The correlation coefficient of the detrended vertical gust/southerly wind component pair. |
| CORC_VERT_ALONG_WIND_DET | The correlation coefficient of the detrended vertical gust/along wind component pair. |
| CORC_VERT_CROSS_WIND_DET | The correlation coefficient of the detrended vertical gust/cross wind component pair. |
| CORC_VERT_POTNTL_TEMP_DET | The correlation coefficient of the detrended vertical gust/potential temperature pair. |
| CORC_VERT_H2O_MIX_RATIO_DET | The correlation coefficient of the detrended vertical gust/water vapor mixing ratio pair. |
| CORC_VERT_CO2_MIX_RATIO_DET | The correlation coefficient of the detrended vertical gust/carbon dioxide mixing ratio pair. |
| CORC_VERT_O3_CONC_DET | The correlation coefficient of the detrended vertical gust/ozone concentration pair. |
| CORC_VERT_CH4_CONC_DET | The correlation coefficient of the detrended vertical gust/methane concentration pair. |
| CORC_POTNTL_H2O_MIX_RATIO_DET | The correlation coefficient of the detrended potential temperature/water vapor mixing ratio pair. |
| MMNTM_FLUX_U_WIND_COMPNT_DET | The momentum flux using the detrended westerly wind component. |
| MMNTM_FLUX_V_WIND_COMPNT_DET | The momentum flux using the detrended southerly wind component. |
| MMNTM_FLUX_ALONG_MEAN_WIND_DET | The momentum flux using the detrended along mean wind component. |
| MMNTM_FLUX_CROSS_MEAN_WIND_DET | The momentum flux using the detrended across mean wind component. |
| SENSIBLE_HEAT_FLUX_DET | The detrended sensible heat flux. |
| LATENT_HEAT_FLUX_DET | The detrended latent heat flux. |
| CO2_FLUX_DET | The detrended carbon dioxide flux. |
| O3_FLUX_DET | The detrended ozone flux. |
| O3_DEPOSITION_VELOC_DET | The detrended ozone deposition velocity. |
| CH4_FLUX_DET | The detrended methane flux. |
| CRTFCN_CODE | The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable). |
| REVISION_DATE | The most recent date when the information in the referenced data base table record was revised. |

### 7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

| Column Name | Units |
|---|---|
| SPATIAL_COVERAGE | [none] |
| RUN_START_DATE | [DD-MON-YY] |
| RUN_START_TIME | [HHMMSS GMT] |
| RUN_END_DATE | [DD-MON-YY] |

| | |
|---|---|
| RUN_END_TIME | [HHMMSS GMT] |
| FLUX_MISSION_DESIGNATOR | [none] |
| FLUX_MISSION_NUM | [unitless] |
| FLUX_PASS_NUM | [unitless] |
| FLUX_SEGMENT_NUM | [unitless] |
| START_LATITUDE | [degrees] |
| START_LONGITUDE | [degrees] |
| END_LATITUDE | [degrees] |
| END_LONGITUDE | [degrees] |
| START_BOREAS_X | [kilometers] |
| START_BOREAS_Y | [kilometers] |
| END_BOREAS_X | [kilometers] |
| END_BOREAS_Y | [kilometers] |
| HEADING | [degrees] |
| MEAN_PRESS_ALTITUDE | [meters] |
| MEAN_RADAR_ALTITUDE | [meters] |
| MEAN_WIND_DIR | [degrees] |
| MEAN_WIND_SPEED | [meters][second^-1] |
| MEAN_AIR_TEMP | [degrees Celsius] |
| MEAN_POTNTL_TEMP | [degrees Kelvin] |
| MEAN_H2O_MIX_RATIO | [grams of water vapor][kilogram dry air^-1] |
| MEAN_U_COMPNT_WIND_VELOC | [meters][second^-1] |
| MEAN_V_COMPNT_WIND_VELOC | [meters][second^-1] |
| MEAN_STATIC_PRESS | [kiloPascals] |
| MEAN_SURF_RAD_TEMP | [degrees Celsius] |
| MEAN_DOWN_TOTAL_RAD | [Watts][meter^-2] |
| MEAN_UP_TOTAL_RAD | [Watts][meter^-2] |
| MEAN_DOWN_LONGWAVE_RAD | [Watts][meter^-2] |
| MEAN_UP_LONGWAVE_RAD | [Watts][meter^-2] |
| MEAN_NET_RAD | [Watts][meter^-2] |
| MEAN_UP_PPFD | [microEinsteins][meter^-2][second^-1] |
| MEAN_DOWN_PPFD | [microEinsteins][meter^-2][second^-1] |
| MEAN_AUX_RAD | [Watts][meter^-2] |
| MEAN_GREEN_INDEX | [unitless] |
| MEAN_CO2_CONC | [micromoles CO2][mole air^-1] |
| MEAN_O3_CONC | [nanomoles O3][mole air^-1] |
| MEAN_CH4_CONC | [nanomoles CH4][mole air^-1] |
| MEAN_SAT_SIM_CH1 | [unitless] |
| MEAN_SAT_SIM_CH2 | [unitless] |
| MEAN_SAT_SIM_CH3 | [unitless] |
| MEAN_SAT_SIM_CH4 | [unitless] |
| SDEV_AIR_TEMP | [degrees Celsius] |
| SDEV_POTNTL_TEMP | [degrees Kelvin] |
| SDEV_H2O_MIX_RATIO | [grams of water vapor][kilogram dry air^-1] |
| SDEV_U_COMPNT_WIND_VELOC | [meters][second^-1] |
| SDEV_V_COMPNT_WIND_VELOC | [meters][second^-1] |
| SDEV_STATIC_PRESS | [kiloPascals] |
| SDEV_SURF_RAD_TEMP | [degrees Celsius] |
| SDEV_DOWN_TOTAL_RAD | [Watts][meter^-2] |
| SDEV_UP_TOTAL_RAD | [Watts][meter^-2] |
| SDEV_DOWN_LONGWAVE_RAD | [Watts][meter^-2] |
| SDEV_UP_LONGWAVE_RAD | [Watts][meter^-2] |
| SDEV_NET_RAD | [Watts][meter^-2] |
| SDEV_UP_PPFD | [microEinsteins][meter^-2][second^-1] |

| | |
|---|---|
| SDEV_DOWN_PPFD | [microEinsteins][meter^-2][second^-1] |
| SDEV_AUX_RAD | [unitless] |
| SDEV_GREEN_INDEX | [unitless] |
| SDEV_CO2_CONC | [micromoles CO2][mole air^-1] |
| SDEV_O3_CONC | [nanomoles O3][mole air^-1] |
| SDEV_CH4_CONC | [nanomoles CH4][mole air^-1] |
| SDEV_SAT_SIM_CH1 | [unitless] |
| SDEV_SAT_SIM_CH2 | [unitless] |
| SDEV_SAT_SIM_CH3 | [unitless] |
| SDEV_SAT_SIM_CH4 | [unitless] |
| TREND_AIR_TEMP | [degrees Celsius][meter^-1] |
| TREND_POTNTL_TEMP | [degrees Kelvin][meter^-1] |
| TREND_H2O_MIX_RATIO | [grams of water vapor][kilogram dry air^-1] [meter^-1] |
| TREND_U_COMPNT_WIND_VELOC | [second^-1] |
| TREND_V_COMPNT_WIND_VELOC | [second^-1] |
| TREND_STATIC_PRESS | [kiloPascals][meter^-1] |
| TREND_SURF_RAD_TEMP | [degrees Celsius][meter^-1] |
| TREND_DOWN_TOTAL_RAD | [Watts][meter^-3] |
| TREND_UP_TOTAL_RAD | [Watts][meter^-3] |
| TREND_DOWN_LONGWAVE_RAD | [Watts][meter^-3] |
| TREND_UP_LONGWAVE_RAD | [Watts][meter^-3] |
| TREND_GREEN_INDEX | [meter^-1] |
| TREND_CO2_CONC | [micromoles CO2][mole air^-1][meter^-1] |
| TREND_O3_CONC | [nanomoles O3][mole air^-1][meter^-1] |
| TREND_CH4_CONC | [nanomoles CH4][mole air^-1][meter^-1] |
| SDEV_VERT_GUST_RAW | [meters][second^-1] |
| SDEV_U_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| SDEV_V_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| SDEV_ALONG_WIND_RAW | [meters][second^-1] |
| SDEV_CROSS_WIND_RAW | [meters][second^-1] |
| SDEV_POTNTL_TEMP_RAW | [degrees Kelvin] |
| SDEV_H2O_MIX_RATIO_RAW | [grams of water vapor][kilogram dry air^-1] |
| SDEV_CO2_MIX_RATIO_RAW | [unitless] |
| SDEV_O3_CONC_RAW | [nanomoles O3][mole air^-1] |
| SDEV_CH4_CONC_RAW | [nanomoles CH4][mole air^-1] |
| SKEW_VERT_GUST_RAW | [meters][second^-1] |
| SKEW_U_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| SKEW_V_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| SKEW_ALONG_WIND_RAW | [meters][second^-1] |
| SKEW_CROSS_WIND_RAW | [meters][second^-1] |
| SKEW_POTNTL_TEMP_RAW | [degrees Kelvin] |
| SKEW_H2O_MIX_RATIO_RAW | [grams of water vapor][kilogram dry air^-1] |
| SKEW_CO2_MIX_RATIO | [unitless] |
| SKEW_O3_CONC_RAW | [nanomoles O3][mole air^-1] |
| SKEW_CH4_CONC_RAW | [nanomoles CH4][mole air^-1] |
| KURT_VERT_GUST_RAW | [meters][second^-1] |
| KURT_U_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| KURT_V_COMPNT_WIND_VELOC_RAW | [meters][second^-1] |
| KURT_ALONG_WIND_RAW | [meters][second^-1] |
| KURT_CROSS_WIND_RAW | [meters][second^-1] |
| KURT_POTNTL_TEMP_RAW | [degrees Kelvin] |
| KURT_H2O_MIX_RATIO_RAW | [grams of water vapor][kilogram dry air^-1] |
| KURT_CO2_MIX_RATIO_RAW | [unitless] |

| | |
|---|---|
| KURT_O3_CONC_RAW | [nanomoles O3][mole air^-1] |
| KURT_CH4_CONC_RAW | [nanomoles CH4][mole air^-1] |
| CORC_VERT_U_WIND_COMPNT_RAW | [meters^2][second^-2] |
| CORC_VERT_V_WIND_COMPNT_RAW | [meters^2][second^-2] |
| CORC_VERT_ALONG_WIND_RAW | [meters^2][second^-2] |
| CORC_VERT_CROSS_WIND_RAW | [meters^2][second^-2] |
| CORC_VERT_POTNTL_TEMP_RAW | [degrees Kelvin][meters][second^-1] |
| CORC_VERT_H2O_MIX_RATIO_RAW | [grams of water vapor][meters] [kilogram dry air^-1][second^-1] |
| CORC_VERT_CO2_MIX_RATIO_RAW | [unitless] |
| CORC_VERT_O3_CONC_RAW | [nanomoles O3][meters][mole air^-1][second^-1] |
| CORC_VERT_CH4_CONC_RAW | [nanomoles CH4][meters][mole air^-1][second^-1] |
| CORC_POTNTL_H2O_MIX_RATIO_RAW | [grams of water vapor][degrees Kelvin] [kilogram dry air^-1] |
| MMNTM_FLUX_V_WIND_COMPNT_RAW | [Newtons][meter^-2] |
| MMNTM_FLUX_U_WIND_COMPNT_RAW | [Newtons][meter^-2] |
| MMNTM_FLUX_ALONG_MEAN_WIND_RAW | [Newtons][meter^-2] |
| MMNTM_FLUX_CROSS_MEAN_WIND_RAW | [Newtons][meter^-2] |
| SENSIBLE_HEAT_FLUX_RAW | [Watts][meter^-2] |
| LATENT_HEAT_FLUX_RAW | [Watts][meter^-2] |
| CO2_FLUX_RAW | [micromoles CO2][meter^-2][second^-1] |
| O3_FLUX_RAW | [nanomoles O3][meter^-2][second^-1] |
| O3_DEPOSITION_VELOC_RAW | [millimeters][second^-1] |
| CH4_FLUX_RAW | [nanomoles CH4][meter^-2][second^-1] |
| AIR_DENSITY_CONSTANT | [kilograms][meter^-3] |
| SPECIFIC_HEAT_CONSTANT | [Joules][kilogram^-1][degree Kelvin^-1] |
| LATENT_HEAT_VAP_CONSTANT | [Joules][kilogram^-1] |
| DRY_AIR_GAS_CONSTANT | [Joules][kilogram^-1][degree Kelvin^-1] |
| SDEV_VERT_GUST_DET | [meters][second^-1] |
| SDEV_U_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| SDEV_V_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| SDEV_ALONG_WIND_DET | [meters][second^-1] |
| SDEV_CROSS_WIND_DET | [meters][second^-1] |
| SDEV_POTNTL_TEMP_DET | [degrees Kelvin] |
| SDEV_H2O_MIX_RATIO_DET | [grams of water vapor][kilogram dry air^-1] |
| SDEV_CO2_MIX_RATIO | [unitless] |
| SDEV_O3_CONC_DET | [nanomoles O3][mole air^-1] |
| SDEV_CH4_CONC_DET | [nanomoles CH4][mole air^-1] |
| SKEW_VERT_GUST_DET | [meters][second^-1] |
| SKEW_U_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| SKEW_V_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| SKEW_ALONG_WIND_DET | [meters][second^-1] |
| SKEW_CROSS_WIND_DET | [meters][second^-1] |
| SKEW_POTNTL_TEMP_DET | [degrees Kelvin] |
| SKEW_H2O_MIX_RATIO_DET | [grams of water vapor][kilogram dry air^-1] |
| SKEW_CO2_MIX_RATIO_DET | [unitless] |
| SKEW_O3_CONC_DET | [nanomoles O3][mole air^-1] |
| SKEW_CH4_CONC_DET | [nanomoles CH4][mole air^-1] |
| KURT_VERT_GUST_DET | [meters][second^-1] |
| KURT_U_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| KURT_V_COMPNT_WIND_VELOC_DET | [meters][second^-1] |
| KURT_ALONG_WIND_DET | [meters][second^-1] |
| KURT_CROSS_WIND_DET | [meters][second^-1] |
| KURT_POTNTL_TEMP_DET | [degrees Kelvin] |

| | |
|---|---|
| KURT_H2O_MIX_RATIO_DET | [grams of water vapor][kilogram dry air^-1] |
| KURT_CO2_MIX_RATIO_DET | [unitless] |
| KURT_O3_CONC_DET | [nanomoles O3][mole air^-1] |
| KURT_CH4_CONC_DET | [nanomoles CH4][mole air^-1] |
| CORC_VERT_U_WIND_COMPNT_DET | [meters^2][second^-2] |
| CORC_VERT_V_WIND_COMPNT_DET | [meters^2][second^-2] |
| CORC_VERT_ALONG_WIND_DET | [meters^2][second^-2] |
| CORC_VERT_CROSS_WIND_DET | [meters^2][second^-2] |
| CORC_VERT_POTNTL_TEMP_DET | [degrees Kelvin][meters][second^-1] |
| CORC_VERT_H2O_MIX_RATIO_DET | [grams of water vapor][meters] [kilogram dry air^-1][second^-1] |
| CORC_VERT_CO2_MIX_RATIO_DET | [unitless] |
| CORC_VERT_O3_CONC_DET | [nanomoles O3][meters][mole air^-1][second^-1] |
| CORC_VERT_CH4_CONC_DET | [nanomoles CH4][meters][mole air^-1][second^-1] |
| CORC_POTNTL_H2O_MIX_RATIO_DET | [grams of water vapor][degrees Kelvin] [kilogram dry air^-1] |
| MMNTM_FLUX_U_WIND_COMPNT_DET | [Newtons][meter^-2] |
| MMNTM_FLUX_V_WIND_COMPNT_DET | [Newtons][meter^-2] |
| MMNTM_FLUX_ALONG_MEAN_WIND_DET | [Newtons][meter^-2] |
| MMNTM_FLUX_CROSS_MEAN_WIND_DET | [Newtons][meter^-2] |
| SENSIBLE_HEAT_FLUX_DET | [Watts][meter^-2] |
| LATENT_HEAT_FLUX_DET | [Watts][meter^-2] |
| CO2_FLUX_DET | [micromoles CO2][meter^-2][second^-1] |
| O3_FLUX_DET | [nanomoles O3][meter^-2][second^-1] |
| O3_DEPOSITION_VELOC_DET | [millimeters][second^-1] |
| CH4_FLUX_DET | [nanomoles CH4][meter^-2][second^-1] |
| CRTFCN_CODE | [none] |
| REVISION_DATE | [DD-MON-YY] |

### 7.3.4 Data Source

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

| Column Name | Data Source |
|---|---|
| SPATIAL_COVERAGE | [Assigned by BORIS] |
| RUN_START_DATE | [Supplied by Investigator] |
| RUN_START_TIME | [Supplied by Investigator] |
| RUN_END_DATE | [Supplied by Investigator] |
| RUN_END_TIME | [Supplied by Investigator] |
| FLUX_MISSION_DESIGNATOR | [Supplied by Investigator] |
| FLUX_MISSION_NUM | [Supplied by Investigator] |
| FLUX_PASS_NUM | [Supplied by Investigator] |
| FLUX_SEGMENT_NUM | [Supplied by Investigator] |
| START_LATITUDE | [Supplied by Investigator] |
| START_LONGITUDE | [Supplied by Investigator] |
| END_LATITUDE | [Supplied by Investigator] |
| END_LONGITUDE | [Supplied by Investigator] |
| START_BOREAS_X | [Supplied by Investigator] |
| START_BOREAS_Y | [Supplied by Investigator] |
| END_BOREAS_X | [Supplied by Investigator] |
| END_BOREAS_Y | [Supplied by Investigator] |
| HEADING | [Supplied by Investigator] |
| MEAN_PRESS_ALTITUDE | [Supplied by Investigator] |
| MEAN_RADAR_ALTITUDE | [Supplied by Investigator] |

| | |
|---|---|
| MEAN_WIND_DIR | [Supplied by Investigator] |
| MEAN_WIND_SPEED | [Supplied by Investigator] |
| MEAN_AIR_TEMP | [Supplied by Investigator] |
| MEAN_POTNTL_TEMP | [Supplied by Investigator] |
| MEAN_H2O_MIX_RATIO | [Supplied by Investigator] |
| MEAN_U_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| MEAN_V_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| MEAN_STATIC_PRESS | [Supplied by Investigator] |
| MEAN_SURF_RAD_TEMP | [Supplied by Investigator] |
| MEAN_DOWN_TOTAL_RAD | [Supplied by Investigator] |
| MEAN_UP_TOTAL_RAD | [Supplied by Investigator] |
| MEAN_DOWN_LONGWAVE_RAD | [Supplied by Investigator] |
| MEAN_UP_LONGWAVE_RAD | [Supplied by Investigator] |
| MEAN_NET_RAD | [Supplied by Investigator] |
| MEAN_UP_PPFD | [Supplied by Investigator] |
| MEAN_DOWN_PPFD | [Supplied by Investigator] |
| MEAN_AUX_RAD | [Supplied by Investigator] |
| MEAN_GREEN_INDEX | [Supplied by Investigator] |
| MEAN_CO2_CONC | [Supplied by Investigator] |
| MEAN_O3_CONC | [Supplied by Investigator] |
| MEAN_CH4_CONC | [Supplied by Investigator] |
| MEAN_SAT_SIM_CH1 | [Supplied by Investigator] |
| MEAN_SAT_SIM_CH2 | [Supplied by Investigator] |
| MEAN_SAT_SIM_CH3 | [Supplied by Investigator] |
| MEAN_SAT_SIM_CH4 | [Supplied by Investigator] |
| SDEV_AIR_TEMP | [Supplied by Investigator] |
| SDEV_POTNTL_TEMP | [Supplied by Investigator] |
| SDEV_H2O_MIX_RATIO | [Supplied by Investigator] |
| SDEV_U_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| SDEV_V_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| SDEV_STATIC_PRESS | [Supplied by Investigator] |
| SDEV_SURF_RAD_TEMP | [Supplied by Investigator] |
| SDEV_DOWN_TOTAL_RAD | [Supplied by Investigator] |
| SDEV_UP_TOTAL_RAD | [Supplied by Investigator] |
| SDEV_DOWN_LONGWAVE_RAD | [Supplied by Investigator] |
| SDEV_UP_LONGWAVE_RAD | [Supplied by Investigator] |
| SDEV_NET_RAD | [Supplied by Investigator] |
| SDEV_UP_PPFD | [Supplied by Investigator] |
| SDEV_DOWN_PPFD | [Supplied by Investigator] |
| SDEV_AUX_RAD | [Supplied by Investigator] |
| SDEV_GREEN_INDEX | [Supplied by Investigator] |
| SDEV_CO2_CONC | [Supplied by Investigator] |
| SDEV_O3_CONC | [Supplied by Investigator] |
| SDEV_CH4_CONC | [Supplied by Investigator] |
| SDEV_SAT_SIM_CH1 | [Supplied by Investigator] |
| SDEV_SAT_SIM_CH2 | [Supplied by Investigator] |
| SDEV_SAT_SIM_CH3 | [Supplied by Investigator] |
| SDEV_SAT_SIM_CH4 | [Supplied by Investigator] |
| TREND_AIR_TEMP | [Supplied by Investigator] |
| TREND_POTNTL_TEMP | [Supplied by Investigator] |
| TREND_H2O_MIX_RATIO | [Supplied by Investigator] |
| TREND_U_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| TREND_V_COMPNT_WIND_VELOC | [Supplied by Investigator] |
| TREND_STATIC_PRESS | [Supplied by Investigator] |

| | |
|---|---|
| TREND_SURF_RAD_TEMP | [Supplied by Investigator] |
| TREND_DOWN_TOTAL_RAD | [Supplied by Investigator] |
| TREND_UP_TOTAL_RAD | [Supplied by Investigator] |
| TREND_DOWN_LONGWAVE_RAD | [Supplied by Investigator] |
| TREND_UP_LONGWAVE_RAD | [Supplied by Investigator] |
| TREND_GREEN_INDEX | [Supplied by Investigator] |
| TREND_CO2_CONC | [Supplied by Investigator] |
| TREND_O3_CONC | [Supplied by Investigator] |
| TREND_CH4_CONC | [Supplied by Investigator] |
| SDEV_VERT_GUST_RAW | [Supplied by Investigator] |
| SDEV_U_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| SDEV_V_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| SDEV_ALONG_WIND_RAW | [Supplied by Investigator] |
| SDEV_CROSS_WIND_RAW | [Supplied by Investigator] |
| SDEV_POTNTL_TEMP_RAW | [Supplied by Investigator] |
| SDEV_H2O_MIX_RATIO_RAW | [Supplied by Investigator] |
| SDEV_CO2_MIX_RATIO_RAW | [Supplied by Investigator] |
| SDEV_O3_CONC_RAW | [Supplied by Investigator] |
| SDEV_CH4_CONC_RAW | [Supplied by Investigator] |
| SKEW_VERT_GUST_RAW | [Supplied by Investigator] |
| SKEW_U_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| SKEW_V_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| SKEW_ALONG_WIND_RAW | [Supplied by Investigator] |
| SKEW_CROSS_WIND_RAW | [Supplied by Investigator] |
| SKEW_POTNTL_TEMP_RAW | [Supplied by Investigator] |
| SKEW_H2O_MIX_RATIO_RAW | [Supplied by Investigator] |
| SKEW_CO2_MIX_RATIO | [Supplied by Investigator] |
| SKEW_O3_CONC_RAW | [Supplied by Investigator] |
| SKEW_CH4_CONC_RAW | [Supplied by Investigator] |
| KURT_VERT_GUST_RAW | [Supplied by Investigator] |
| KURT_U_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| KURT_V_COMPNT_WIND_VELOC_RAW | [Supplied by Investigator] |
| KURT_ALONG_WIND_RAW | [Supplied by Investigator] |
| KURT_CROSS_WIND_RAW | [Supplied by Investigator] |
| KURT_POTNTL_TEMP_RAW | [Supplied by Investigator] |
| KURT_H2O_MIX_RATIO_RAW | [Supplied by Investigator] |
| KURT_CO2_MIX_RATIO_RAW | [Supplied by Investigator] |
| KURT_O3_CONC_RAW | [Supplied by Investigator] |
| KURT_CH4_CONC_RAW | [Supplied by Investigator] |
| CORC_VERT_U_WIND_COMPNT_RAW | [Supplied by Investigator] |
| CORC_VERT_V_WIND_COMPNT_RAW | [Supplied by Investigator] |
| CORC_VERT_ALONG_WIND_RAW | [Supplied by Investigator] |
| CORC_VERT_CROSS_WIND_RAW | [Supplied by Investigator] |
| CORC_VERT_POTNTL_TEMP_RAW | [Supplied by Investigator] |
| CORC_VERT_H2O_MIX_RATIO_RAW | [Supplied by Investigator] |
| CORC_VERT_CO2_MIX_RATIO_RAW | [Supplied by Investigator] |
| CORC_VERT_O3_CONC_RAW | [Supplied by Investigator] |
| CORC_VERT_CH4_CONC_RAW | [Supplied by Investigator] |
| CORC_POTNTL_H2O_MIX_RATIO_RAW | [Supplied by Investigator] |
| MMNTM_FLUX_V_WIND_COMPNT_RAW | [Supplied by Investigator] |
| MMNTM_FLUX_U_WIND_COMPNT_RAW | [Supplied by Investigator] |
| MMNTM_FLUX_ALONG_MEAN_WIND_RAW | [Supplied by Investigator] |
| MMNTM_FLUX_CROSS_MEAN_WIND_RAW | [Supplied by Investigator] |
| SENSIBLE_HEAT_FLUX_RAW | [Supplied by Investigator] |

| | |
|---|---|
| LATENT_HEAT_FLUX_RAW | [Supplied by Investigator] |
| CO2_FLUX_RAW | [Supplied by Investigator] |
| O3_FLUX_RAW | [Supplied by Investigator] |
| O3_DEPOSITION_VELOC_RAW | [Supplied by Investigator] |
| CH4_FLUX_RAW | [Supplied by Investigator] |
| AIR_DENSITY_CONSTANT | [Supplied by Investigator] |
| SPECIFIC_HEAT_CONSTANT | [Supplied by Investigator] |
| LATENT_HEAT_VAP_CONSTANT | [Supplied by Investigator] |
| DRY_AIR_GAS_CONSTANT | [Supplied by Investigator] |
| SDEV_VERT_GUST_DET | [Supplied by Investigator] |
| SDEV_U_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| SDEV_V_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| SDEV_ALONG_WIND_DET | [Supplied by Investigator] |
| SDEV_CROSS_WIND_DET | [Supplied by Investigator] |
| SDEV_POTNTL_TEMP_DET | [Supplied by Investigator] |
| SDEV_H2O_MIX_RATIO_DET | [Supplied by Investigator] |
| SDEV_CO2_MIX_RATIO | [Supplied by Investigator] |
| SDEV_O3_CONC_DET | [Supplied by Investigator] |
| SDEV_CH4_CONC_DET | [Supplied by Investigator] |
| SKEW_VERT_GUST_DET | [Supplied by Investigator] |
| SKEW_U_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| SKEW_V_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| SKEW_ALONG_WIND_DET | [Supplied by Investigator] |
| SKEW_CROSS_WIND_DET | [Supplied by Investigator] |
| SKEW_POTNTL_TEMP_DET | [Supplied by Investigator] |
| SKEW_H2O_MIX_RATIO_DET | [Supplied by Investigator] |
| SKEW_CO2_MIX_RATIO_DET | [Supplied by Investigator] |
| SKEW_O3_CONC_DET | [Supplied by Investigator] |
| SKEW_CH4_CONC_DET | [Supplied by Investigator] |
| KURT_VERT_GUST_DET | [Supplied by Investigator] |
| KURT_U_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| KURT_V_COMPNT_WIND_VELOC_DET | [Supplied by Investigator] |
| KURT_ALONG_WIND_DET | [Supplied by Investigator] |
| KURT_CROSS_WIND_DET | [Supplied by Investigator] |
| KURT_POTNTL_TEMP_DET | [Supplied by Investigator] |
| KURT_H2O_MIX_RATIO_DET | [Supplied by Investigator] |
| KURT_CO2_MIX_RATIO_DET | [Supplied by Investigator] |
| KURT_O3_CONC_DET | [Supplied by Investigator] |
| KURT_CH4_CONC_DET | [Supplied by Investigator] |
| CORC_VERT_U_WIND_COMPNT_DET | [Supplied by Investigator] |
| CORC_VERT_V_WIND_COMPNT_DET | [Supplied by Investigator] |
| CORC_VERT_ALONG_WIND_DET | [Supplied by Investigator] |
| CORC_VERT_CROSS_WIND_DET | [Supplied by Investigator] |
| CORC_VERT_POTNTL_TEMP_DET | [Supplied by Investigator] |
| CORC_VERT_H2O_MIX_RATIO_DET | [Supplied by Investigator] |
| CORC_VERT_CO2_MIX_RATIO_DET | [Supplied by Investigator] |
| CORC_VERT_O3_CONC_DET | [Supplied by Investigator] |
| CORC_VERT_CH4_CONC_DET | [Supplied by Investigator] |
| CORC_POTNTL_H2O_MIX_RATIO_DET | [Supplied by Investigator] |
| MMNTM_FLUX_U_WIND_COMPNT_DET | [Supplied by Investigator] |
| MMNTM_FLUX_V_WIND_COMPNT_DET | [Supplied by Investigator] |
| MMNTM_FLUX_ALONG_MEAN_WIND_DET | [Supplied by Investigator] |
| MMNTM_FLUX_CROSS_MEAN_WIND_DET | [Supplied by Investigator] |
| SENSIBLE_HEAT_FLUX_DET | [Supplied by Investigator] |

| | |
|---|---|
| LATENT_HEAT_FLUX_DET | [Supplied by Investigator] |
| CO2_FLUX_DET | [Supplied by Investigator] |
| O3_FLUX_DET | [Supplied by Investigator] |
| O3_DEPOSITION_VELOC_DET | [Supplied by Investigator] |
| CH4_FLUX_DET | [Supplied by Investigator] |
| CRTFCN_CODE | [Assigned by BORIS] |
| REVISION_DATE | [Assigned by BORIS] |

### 7.3.5 Data Range

The following table gives information about the parameter values contained in the data files on the CD-ROM:

| Column Name | Minimum Data Value | Maximum Data Value | Missng Data Value | Unrel Data Value | Below Detect Limit | Data Not Cllctd |
|---|---|---|---|---|---|---|
| SPATIAL_COVERAGE | N/A | N/A | None | None | None | None |
| RUN_START_DATE | 25-MAY-94 | 15-SEP-94 | None | None | None | None |
| RUN_START_TIME | 1329 | 235845 | None | None | None | None |
| RUN_END_DATE | 25-MAY-94 | 15-SEP-94 | None | None | None | None |
| RUN_END_TIME | 1429 | 235945 | None | None | None | None |
| FLUX_MISSION_ DESIGNATOR | CS | XX | None | None | None | None |
| FLUX_MISSION_NUM | 1 | 4 | None | None | None | None |
| FLUX_PASS_NUM | 1 | 45 | None | None | None | None |
| FLUX_SEGMENT_NUM | 1 | 106 | None | None | None | None |
| START_LATITUDE | 53.53872 | 54.14089 | None | None | None | None |
| START_LONGITUDE | -106.56947 | -102.91473 | None | None | None | None |
| END_LATITUDE | 53.53492 | 54.14185 | None | None | None | None |
| END_LONGITUDE | -106.57997 | -102.91473 | None | None | None | None |
| START_BOREAS_X | 292.631 | 531.101 | None | None | None | None |
| START_BOREAS_Y | 293.088 | 365.07 | None | None | None | None |
| END_BOREAS_X | 291.976 | 531.242 | None | None | None | None |
| END_BOREAS_Y | 292.951 | 365.389 | None | None | None | None |
| HEADING | .2 | 359.6 | None | None | None | None |
| MEAN_PRESS_ALTITUDE | -593.9 | 873.1 | -999 | None | None | None |
| MEAN_RADAR_ALTITUDE | 12.2 | 762 | -999 | None | None | None |
| MEAN_WIND_DIR | 0 | 359.9 | None | None | None | None |
| MEAN_WIND_SPEED | .02 | 22.35 | None | None | None | None |
| MEAN_AIR_TEMP | 7.85 | 26.98 | None | None | None | None |
| MEAN_POTNTL_TEMP | 285.2 | 305.22 | None | None | None | None |
| MEAN_H2O_MIX_RATIO | .08 | 13.15 | None | None | None | None |
| MEAN_U_COMPNT_WIND_ VELOC | -16.35 | 15.14 | None | None | None | None |
| MEAN_V_COMPNT_WIND_ VELOC | -9.37 | 16.44 | None | None | None | None |
| MEAN_STATIC_PRESS | 91.52 | 96.65 | None | None | None | None |
| MEAN_SURF_RAD_TEMP | 4.1 | 41 | None | None | None | None |
| MEAN_DOWN_TOTAL_RAD | | | -999 | None | None | None |
| MEAN_UP_TOTAL_RAD | | | -999 | None | None | None |
| MEAN_DOWN_LONGWAVE_ RAD | | | -999 | None | None | None |
| MEAN_UP_LONGWAVE_RAD | | | -999 | None | None | None |
| MEAN_NET_RAD | -54.6 | 807.1 | -999 | None | None | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| MEAN_UP_PPFD | 10.6 | 405.5 | None | None | None | None |
| MEAN_DOWN_PPFD | -8.8 | 2234.3 | None | None | None | None |
| MEAN_AUX_RAD | | | -999 | None | None | None |
| MEAN_GREEN_INDEX | | | -999 | None | None | None |
| MEAN_CO2_CONC | 516.5 | 677.9 | None | None | None | None |
| MEAN_O3_CONC | | | -999 | None | None | None |
| MEAN_CH4_CONC | | | -999 | None | None | None |
| MEAN_SAT_SIM_CH1 | | | -999 | None | None | None |
| MEAN_SAT_SIM_CH2 | | | -999 | None | None | None |
| MEAN_SAT_SIM_CH3 | | | -999 | None | None | None |
| MEAN_SAT_SIM_CH4 | | | -999 | None | None | None |
| SDEV_AIR_TEMP | .1 | 1.66 | None | None | None | None |
| SDEV_POTNTL_TEMP | .1 | 1.81 | None | None | None | None |
| SDEV_H2O_MIX_RATIO | .1 | 8.58 | None | None | None | None |
| SDEV_U_COMPNT_WIND_VELOC | .2 | 23.81 | None | None | None | None |
| SDEV_V_COMPNT_WIND_VELOC | .1 | 26.52 | None | None | None | None |
| SDEV_STATIC_PRESS | .1 | 17.5 | None | None | None | None |
| SDEV_SURF_RAD_TEMP | .1 | 11.62 | None | None | None | None |
| SDEV_DOWN_TOTAL_RAD | | | -999 | None | None | None |
| SDEV_UP_TOTAL_RAD | | | -999 | None | None | None |
| SDEV_DOWN_LONGWAVE_RAD | | | -999 | None | None | None |
| SDEV_UP_LONGWAVE_RAD | | | -999 | None | None | None |
| SDEV_NET_RAD | .1 | 227.2 | None | None | None | None |
| SDEV_UP_PPFD | .4 | 136.6 | None | None | None | None |
| SDEV_DOWN_PPFD | .3 | 871.1 | None | None | None | None |
| SDEV_AUX_RAD | | | -999 | None | None | None |
| SDEV_GREEN_INDEX | | | -999 | None | None | None |
| SDEV_CO2_CONC | .1 | 62.2 | None | None | None | None |
| SDEV_O3_CONC | .1 | .1 | None | None | None | None |
| SDEV_CH4_CONC | | | -999 | None | None | None |
| SDEV_SAT_SIM_CH1 | | | -999 | None | None | None |
| SDEV_SAT_SIM_CH2 | | | -999 | None | None | None |
| SDEV_SAT_SIM_CH3 | | | -999 | None | None | None |
| SDEV_SAT_SIM_CH4 | | | -999 | None | None | None |
| TREND_AIR_TEMP | | | -999 | None | None | None |
| TREND_POTNTL_TEMP | | | -999 | None | None | None |
| TREND_H2O_MIX_RATIO | | | -999 | None | None | None |
| TREND_U_COMPNT_WIND_VELOC | | | -999 | None | None | None |
| TREND_V_COMPNT_WIND_VELOC | | | -999 | None | None | None |
| TREND_STATIC_PRESS | | | -999 | None | None | None |
| TREND_SURF_RAD_TEMP | | | -999 | None | None | None |
| TREND_DOWN_TOTAL_RAD | | | -999 | None | None | None |
| TREND_UP_TOTAL_RAD | | | -999 | None | None | None |
| TREND_DOWN_LONGWAVE_RAD | | | -999 | None | None | None |
| TREND_UP_LONGWAVE_RAD | | | -999 | None | None | None |
| TREND_GREEN_INDEX | | | -999 | None | None | None |
| TREND_CO2_CONC | | | -999 | None | None | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| TREND_O3_CONC | | | -999 | None | None | None |
| TREND_CH4_CONC | | | -999 | None | None | None |
| SDEV_VERT_GUST_RAW | .1 | 5.05 | None | None | None | None |
| SDEV_U_COMPNT_WIND_ | .2 | 9.33 | -999 | None | None | None |
| VELOC_RAW | | | | | | |
| SDEV_V_COMPNT_WIND_ | .1 | 9.01 | -999 | None | None | None |
| VELOC_RAW | | | | | | |
| SDEV_ALONG_WIND_RAW | | | -999 | None | None | None |
| SDEV_CROSS_WIND_RAW | | | -999 | None | None | None |
| SDEV_POTNTL_TEMP_RAW | .1 | 1.81 | None | None | None | None |
| SDEV_H2O_MIX_RATIO_ | .1 | 8.58 | None | None | None | None |
| RAW | | | | | | |
| SDEV_CO2_MIX_RATIO_ | .1 | 62.2 | None | None | None | None |
| RAW | | | | | | |
| SDEV_O3_CONC_RAW | | | -999 | None | None | None |
| SDEV_CH4_CONC_RAW | | | -999 | None | None | None |
| SKEW_VERT_GUST_RAW | -4.16 | 3.86 | None | None | None | None |
| SKEW_U_COMPNT_WIND_ | -2.65 | 3.02 | None | None | None | None |
| VELOC_RAW | | | | | | |
| SKEW_V_COMPNT_WIND_ | -2.55 | 3.38 | None | None | None | None |
| VELOC_RAW | | | | | | |
| SKEW_ALONG_WIND_RAW | | | -999 | None | None | None |
| SKEW_CROSS_WIND_RAW | | | -999 | None | None | None |
| SKEW_POTNTL_TEMP_RAW | -4.53 | 4.4 | None | None | None | None |
| SKEW_H2O_MIX_RATIO_ | -3.31 | 3.75 | None | None | None | None |
| RAW | | | | | | |
| SKEW_CO2_MIX_RATIO | -5.09 | 6.45 | None | None | None | None |
| SKEW_O3_CONC_RAW | | | -999 | None | None | None |
| SKEW_CH4_CONC_RAW | | | -999 | None | None | None |
| KURT_VERT_GUST_RAW | .23 | 22.7 | None | None | None | None |
| KURT_U_COMPNT_WIND_ | 1.43 | 14.08 | None | None | None | None |
| VELOC_RAW | | | | | | |
| KURT_V_COMPNT_WIND_ | 1.33 | 15.53 | None | None | None | None |
| VELOC_RAW | | | | | | |
| KURT_ALONG_WIND_RAW | | | -999 | None | None | None |
| KURT_CROSS_WIND_RAW | | | -999 | None | None | None |
| KURT_POTNTL_TEMP_RAW | 0 | 28.66 | None | None | None | None |
| KURT_H2O_MIX_RATIO_ | 0 | 23.83 | None | None | None | None |
| RAW | | | | | | |
| KURT_CO2_MIX_RATIO_ | .35 | 47.46 | None | None | None | None |
| RAW | | | | | | |
| KURT_O3_CONC_RAW | | | -999 | None | None | None |
| KURT_CH4_CONC_RAW | | | -999 | None | None | None |
| CORC_VERT_U_WIND_ | | | -999 | None | None | None |
| COMPNT_RAW | | | | | | |
| CORC_VERT_V_WIND_ | | | -999 | None | None | None |
| COMPNT_RAW | | | | | | |
| CORC_VERT_ALONG_WIND_ | | | -999 | None | None | None |
| RAW | | | | | | |
| CORC_VERT_CROSS_WIND_ | | | -999 | None | None | None |
| RAW | | | | | | |
| CORC_VERT_POTNTL_ | | | -999 | None | None | None |
| TEMP_RAW | | | | | | |
| CORC_VERT_H2O_MIX_ | | | -999 | None | None | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| RATIO_RAW | | | | | | |
| CORC_VERT_CO2_MIX_ RATIO_RAW | | | -999 | None | None | None |
| CORC_VERT_O3_CONC_ RAW | | | -999 | None | None | None |
| CORC_VERT_CH4_CONC_ RAW | | | -999 | None | None | None |
| CORC_POTNTL_H2O_MIX_ RATIO_RAW | | | -999 | None | None | None |
| MMNTM_FLUX_V_WIND_ COMPNT_RAW | -8.2294 | 6.1139 | -999 | None | None | None |
| MMNTM_FLUX_U_WIND_ COMPNT_RAW | -8.3104 | 13.7382 | -999 | None | None | None |
| MMNTM_FLUX_ALONG_ MEAN_WIND_RAW | | | -999 | None | None | None |
| MMNTM_FLUX_CROSS_ MEAN_WIND_RAW | | | -999 | None | None | None |
| SENSIBLE_HEAT_FLUX_ RAW | -460.2 | 699.6 | -999 | None | None | None |
| LATENT_HEAT_FLUX_RAW | -581.2 | 1856.6 | -999 | None | None | None |
| CO2_FLUX_RAW | -9.327 | 17.449 | None | None | None | None |
| O3_FLUX_RAW | | | -999 | None | None | None |
| O3_DEPOSITION_VELOC_ RAW | | | -999 | None | None | None |
| CH4_FLUX_RAW | | | -999 | None | None | None |
| AIR_DENSITY_CONSTANT | 1.079 | 1.172 | None | None | None | None |
| SPECIFIC_HEAT_ CONSTANT | 1004 | 1004 | None | None | None | None |
| LATENT_HEAT_VAP_ CONSTANT | 2434 | 2481 | None | None | None | None |
| DRY_AIR_GAS_CONSTANT | 287.04 | 287.04 | None | None | None | None |
| SDEV_VERT_GUST_DET | | | -999 | None | None | None |
| SDEV_U_COMPNT_WIND_ VELOC_DET | | | -999 | None | None | None |
| SDEV_V_COMPNT_WIND_ VELOC_DET | | | -999 | None | None | None |
| SDEV_ALONG_WIND_DET | | | -999 | None | None | None |
| SDEV_CROSS_WIND_DET | | | -999 | None | None | None |
| SDEV_POTNTL_TEMP_DET | | | -999 | None | None | None |
| SDEV_H2O_MIX_RATIO_ DET | | | -999 | None | None | None |
| SDEV_CO2_MIX_RATIO | | | -999 | None | None | None |
| SDEV_O3_CONC_DET | | | -999 | None | None | None |
| SDEV_CH4_CONC_DET | | | -999 | None | None | None |
| SKEW_VERT_GUST_DET | | | -999 | None | None | None |
| SKEW_U_COMPNT_WIND_ VELOC_DET | | | -999 | None | None | None |
| SKEW_V_COMPNT_WIND_ VELOC_DET | | | -999 | None | None | None |
| SKEW_ALONG_WIND_DET | | | -999 | None | None | None |
| SKEW_CROSS_WIND_DET | | | -999 | None | None | None |
| SKEW_POTNTL_TEMP_DET | | | -999 | None | None | None |
| SKEW_H2O_MIX_RATIO_ DET | | | -999 | None | None | None |

| | | | | |
|---|---|---|---|---|
| SKEW_CO2_MIX_RATIO_DET | -999 | None | None | None |
| SKEW_O3_CONC_DET | -999 | None | None | None |
| SKEW_CH4_CONC_DET | -999 | None | None | None |
| KURT_VERT_GUST_DET | -999 | None | None | None |
| KURT_U_COMPNT_WIND_VELOC_DET | -999 | None | None | None |
| KURT_V_COMPNT_WIND_VELOC_DET | -999 | None | None | None |
| KURT_ALONG_WIND_DET | -999 | None | None | None |
| KURT_CROSS_WIND_DET | -999 | None | None | None |
| KURT_POTNTL_TEMP_DET | -999 | None | None | None |
| KURT_H2O_MIX_RATIO_DET | -999 | None | None | None |
| KURT_CO2_MIX_RATIO_DET | -999 | None | None | None |
| KURT_O3_CONC_DET | -999 | None | None | None |
| KURT_CH4_CONC_DET | -999 | None | None | None |
| CORC_VERT_U_WIND_COMPNT_DET | -999 | None | None | None |
| CORC_VERT_V_WIND_COMPNT_DET | -999 | None | None | None |
| CORC_VERT_ALONG_WIND_DET | -999 | None | None | None |
| CORC_VERT_CROSS_WIND_DET | -999 | None | None | None |
| CORC_VERT_POTNTL_TEMP_DET | -999 | None | None | None |
| CORC_VERT_H2O_MIX_RATIO_DET | -999 | None | None | None |
| CORC_VERT_CO2_MIX_RATIO_DET | -999 | None | None | None |
| CORC_VERT_O3_CONC_DET | -999 | None | None | None |
| CORC_VERT_CH4_CONC_DET | -999 | None | None | None |
| CORC_POTNTL_H2O_MIX_RATIO_DET | -999 | None | None | None |
| MMNTM_FLUX_U_WIND_COMPNT_DET | -999 | None | None | None |
| MMNTM_FLUX_V_WIND_COMPNT_DET | -999 | None | None | None |
| MMNTM_FLUX_ALONG_MEAN_WIND_DET | -999 | None | None | None |
| MMNTM_FLUX_CROSS_MEAN_WIND_DET | -999 | None | None | None |
| SENSIBLE_HEAT_FLUX_DET | -999 | None | None | None |
| LATENT_HEAT_FLUX_DET | -999 | None | None | None |
| CO2_FLUX_DET | -999 | None | None | None |
| O3_FLUX_DET | -999 | None | None | None |
| O3_DEPOSITION_VELOC_DET | -999 | None | None | None |
| CH4_FLUX_DET | -999 | None | None | None |

```
CRTFCN_CODE          CPI            CPI            None     None    None     None
REVISION_DATE        26-APR-99      27-APR-99      None     None    None     None
--------------------------------------------------------------------------------
Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value  -- The value that indicates missing data. This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the attempt was unsuccessful.
Unrel Data Value   -- The value that indicates unreliable data.  This is used
                      to indicate an attempt was made to determine the
                      parameter value, but the value was deemed to be
                      unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the
                      instruments detection limits.  This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the analysis personnel determined
                      that the parameter value was below the detection
                      limit of the instrumentation.
Data Not Cllctd    -- This value indicates that no attempt was made to
                      determine the parameter value.  This usually
                      indicates that BORIS combined several similar but
                      not identical data sets into the same data base table
                      but this particular science team did not
                      measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
--------------------------------------------------------------------------------
```

## 7.4 Sample Data Record

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

```
SPATIAL_COVERAGE,RUN_START_DATE,RUN_START_TIME,RUN_END_DATE,RUN_END_TIME,
FLUX_MISSION_DESIGNATOR,FLUX_MISSION_NUM,FLUX_PASS_NUM,FLUX_SEGMENT_NUM,
START_LATITUDE,START_LONGITUDE,END_LATITUDE,END_LONGITUDE,START_BOREAS_X,
START_BOREAS_Y,END_BOREAS_X,END_BOREAS_Y,HEADING,MEAN_PRESS_ALTITUDE,
MEAN_RADAR_ALTITUDE,MEAN_WIND_DIR,MEAN_WIND_SPEED,MEAN_AIR_TEMP,
MEAN_POTNTL_TEMP,MEAN_H2O_MIX_RATIO,MEAN_U_COMPNT_WIND_VELOC,
MEAN_V_COMPNT_WIND_VELOC,MEAN_STATIC_PRESS,MEAN_SURF_RAD_TEMP,
MEAN_DOWN_TOTAL_RAD,MEAN_UP_TOTAL_RAD,MEAN_DOWN_LONGWAVE_RAD,
MEAN_UP_LONGWAVE_RAD,MEAN_NET_RAD,MEAN_UP_PPFD,MEAN_DOWN_PPFD,MEAN_AUX_RAD,
MEAN_GREEN_INDEX,MEAN_CO2_CONC,MEAN_O3_CONC,MEAN_CH4_CONC,MEAN_SAT_SIM_CH1,
MEAN_SAT_SIM_CH2,MEAN_SAT_SIM_CH3,MEAN_SAT_SIM_CH4,SDEV_AIR_TEMP,
SDEV_POTNTL_TEMP,SDEV_H2O_MIX_RATIO,SDEV_U_COMPNT_WIND_VELOC,
SDEV_V_COMPNT_WIND_VELOC,SDEV_STATIC_PRESS,SDEV_SURF_RAD_TEMP,
SDEV_DOWN_TOTAL_RAD,SDEV_UP_TOTAL_RAD,SDEV_DOWN_LONGWAVE_RAD,
SDEV_UP_LONGWAVE_RAD,SDEV_NET_RAD,SDEV_UP_PPFD,SDEV_DOWN_PPFD,SDEV_AUX_RAD,
SDEV_GREEN_INDEX,SDEV_CO2_CONC,SDEV_O3_CONC,SDEV_CH4_CONC,SDEV_SAT_SIM_CH1,
SDEV_SAT_SIM_CH2,SDEV_SAT_SIM_CH3,SDEV_SAT_SIM_CH4,TREND_AIR_TEMP,
TREND_POTNTL_TEMP,TREND_H2O_MIX_RATIO,TREND_U_COMPNT_WIND_VELOC,
TREND_V_COMPNT_WIND_VELOC,TREND_STATIC_PRESS,TREND_SURF_RAD_TEMP,
TREND_DOWN_TOTAL_RAD,TREND_UP_TOTAL_RAD,TREND_DOWN_LONGWAVE_RAD,
```

```
TREND_UP_LONGWAVE_RAD,TREND_GREEN_INDEX,TREND_CO2_CONC,TREND_O3_CONC,
TREND_CH4_CONC,SDEV_VERT_GUST_RAW,SDEV_U_COMPNT_WIND_VELOC_RAW,
SDEV_V_COMPNT_WIND_VELOC_RAW,SDEV_ALONG_WIND_RAW,SDEV_CROSS_WIND_RAW,
SDEV_POTNTL_TEMP_RAW,SDEV_H2O_MIX_RATIO_RAW,SDEV_CO2_MIX_RATIO_RAW,
SDEV_O3_CONC_RAW,SDEV_CH4_CONC_RAW,SKEW_VERT_GUST_RAW,
SKEW_U_COMPNT_WIND_VELOC_RAW,SKEW_V_COMPNT_WIND_VELOC_RAW,SKEW_ALONG_WIND_RAW,
SKEW_CROSS_WIND_RAW,SKEW_POTNTL_TEMP_RAW,SKEW_H2O_MIX_RATIO_RAW,
SKEW_CO2_MIX_RATIO,SKEW_O3_CONC_RAW,SKEW_CH4_CONC_RAW,KURT_VERT_GUST_RAW,
KURT_U_COMPNT_WIND_VELOC_RAW,KURT_V_COMPNT_WIND_VELOC_RAW,KURT_ALONG_WIND_RAW,
KURT_CROSS_WIND_RAW,KURT_POTNTL_TEMP_RAW,KURT_H2O_MIX_RATIO_RAW,
KURT_CO2_MIX_RATIO_RAW,KURT_O3_CONC_RAW,KURT_CH4_CONC_RAW,
CORC_VERT_U_WIND_COMPNT_RAW,CORC_VERT_V_WIND_COMPNT_RAW,
CORC_VERT_ALONG_WIND_RAW,CORC_VERT_CROSS_WIND_RAW,CORC_VERT_POTNTL_TEMP_RAW,
CORC_VERT_H2O_MIX_RATIO_RAW,CORC_VERT_CO2_MIX_RATIO_RAW,CORC_VERT_O3_CONC_RAW,
CORC_VERT_CH4_CONC_RAW,CORC_POTNTL_H2O_MIX_RATIO_RAW,
MMNTM_FLUX_V_WIND_COMPNT_RAW,MMNTM_FLUX_U_WIND_COMPNT_RAW,
MMNTM_FLUX_ALONG_MEAN_WIND_RAW,MMNTM_FLUX_CROSS_MEAN_WIND_RAW,
SENSIBLE_HEAT_FLUX_RAW,LATENT_HEAT_FLUX_RAW,CO2_FLUX_RAW,O3_FLUX_RAW,
O3_DEPOSITION_VELOC_RAW,CH4_FLUX_RAW,AIR_DENSITY_CONSTANT,
SPECIFIC_HEAT_CONSTANT,LATENT_HEAT_VAP_CONSTANT,DRY_AIR_GAS_CONSTANT,
SDEV_VERT_GUST_DET,SDEV_U_COMPNT_WIND_VELOC_DET,SDEV_V_COMPNT_WIND_VELOC_DET,
SDEV_ALONG_WIND_DET,SDEV_CROSS_WIND_DET,SDEV_POTNTL_TEMP_DET,
SDEV_H2O_MIX_RATIO_DET,SDEV_CO2_MIX_RATIO,SDEV_O3_CONC_DET,SDEV_CH4_CONC_DET,
SKEW_VERT_GUST_DET,SKEW_U_COMPNT_WIND_VELOC_DET,SKEW_V_COMPNT_WIND_VELOC_DET,
SKEW_ALONG_WIND_DET,SKEW_CROSS_WIND_DET,SKEW_POTNTL_TEMP_DET,
SKEW_H2O_MIX_RATIO_DET,SKEW_CO2_MIX_RATIO_DET,SKEW_O3_CONC_DET,
SKEW_CH4_CONC_DET,KURT_VERT_GUST_DET,KURT_U_COMPNT_WIND_VELOC_DET,
KURT_V_COMPNT_WIND_VELOC_DET,KURT_ALONG_WIND_DET,KURT_CROSS_WIND_DET,
KURT_POTNTL_TEMP_DET,KURT_H2O_MIX_RATIO_DET,KURT_CO2_MIX_RATIO_DET,
KURT_O3_CONC_DET,KURT_CH4_CONC_DET,CORC_VERT_U_WIND_COMPNT_DET,
CORC_VERT_V_WIND_COMPNT_DET,CORC_VERT_ALONG_WIND_DET,CORC_VERT_CROSS_WIND_DET,
CORC_VERT_POTNTL_TEMP_DET,CORC_VERT_H2O_MIX_RATIO_DET,
CORC_VERT_CO2_MIX_RATIO_DET,CORC_VERT_O3_CONC_DET,CORC_VERT_CH4_CONC_DET,
CORC_POTNTL_H2O_MIX_RATIO_DET,MMNTM_FLUX_U_WIND_COMPNT_DET,
MMNTM_FLUX_V_WIND_COMPNT_DET,MMNTM_FLUX_ALONG_MEAN_WIND_DET,
MMNTM_FLUX_CROSS_MEAN_WIND_DET,SENSIBLE_HEAT_FLUX_DET,LATENT_HEAT_FLUX_DET,
CO2_FLUX_DET,O3_FLUX_DET,O3_DEPOSITION_VELOC_DET,CH4_FLUX_DET,CRTFCN_CODE,
REVISION_DATE
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-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,'CPI',26-APR-99
```

# 8. Data Organization

### 8.1 Data Granularity

The smallest orderable data set available is one file of flux runs during a day. Note that although there are less than 100 records in any data file, there are over 170 columns of data. Most spreadsheet software should be able to handle up to 256 columns of data.

### 8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain 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

See Section 17.1.

### 9.1.1 Derivation Techniques and Algorithms

See Section 17.1.

### 9.2 Data Processing Sequence

Not available at this revision.

### 9.2.1 Processing Steps

See Section 17.1.

### 9.2.2 Processing Changes

None.

### 9.3 Calculations

### 9.3.1 Special Corrections/Adjustments

None.

### 9.3.2 Calculated Variables

None.

### 9.4 Graphs and Plots

None.

# 10. Errors

### 10.1 Sources of Error
None given.

### 10.2 Quality Assessment

#### 10.2.1 Data Validation by Source
Care has been taken in the collection and analysis of the Long-EZ data. The wind measuring system is continually monitored for accuracy using techniques such as wind boxes, control input cases, and intercomparisons with other aircraft. Cospectral plots have been used to check the flux contributions at all wavelengths to ensure that they were not contaminated by inadequate compensation for aircraft motion.

#### 10.2.2 Confidence Level/Accuracy Judgment
See Section 10.2.1.

#### 10.2.3 Measurement Error for Parameters
Not available.

#### 10.2.4 Additional Quality Assessments
Aircraft intercomparison was made by the investigators.

#### 10.2.5 Data Verification by Data Center
BORIS staff loaded the data into the data base and checked the values to make sure that they were within a reasonable range.

# 11. Notes

### 11.1 Limitations of the Data
None given.

### 11.2 Known Problems with the Data
See Section 6.2.

### 11.3 Usage Guidance
None given.

### 11.4 Other Relevant Information
None.

# 12. Application of the Data Set

These data can be used to create algorithms to relate boundary-layer processes to satellite-derived data.

# 13. Future Modifications and Plans

None.

# 14. Software

## 14.1 Software Description
None.

## 14.2 Software Access
Not applicable.

# 15. Data Access

The NOAA/ATDD Long-EZ aircraft flux data over the SSA 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 http://www-eosdis.ornl.gov/.

## 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

Anderson, D.E., S.B. Verma, R.J. Clement, D.D. Baldocchi, and D.R. Matt. 1986. Turbulence spectra of $CO_2$, water vapor, temperature and velocity over a deciduous forest. Agricultural and Forest Meteorology, 38: 81-99.

Auble, D.L. and T.P. Meyers. 1992. An open path, fast response infrared $H_2O$ and $CO_2$ instrument for atmospheric flux measurements. Boundary-Layer Meteorology, 59, 243-256.

Crawford, T.L. and R.J. Dobosy. 1992. A sensitive fast-response probe to measure turbulence and heat flux from any airplane. Boundary-Layer Meteorology 59:257-278.

Crawford, T.L. and R.T. McMillen. 1991. Direct measurement of $CO_2$ exchange to the ocean using an airborne eddy correlation system. In Proc. of the 7th Conference on Meteorological Observations and Instrumentation, New Orleans, LA, American Meteorological Society, Boston, MA. Preprint Vol. 2.5, pp. 42-45.

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Crawford, T.L., T.T. McMillen, and R.J. Dobosy. 1990. Development of a "Generic" Mobile Flux Platform with Demonstration on a Small Airplane. NOAA Technical Memorandum ERL ARL-184.

Crawford, T.L., T.T. McMillen, and R.J. Dobosy. 1993a. Correcting airborne flux measurements for aircraft speed variation. J. Boundary-Layer Meteorology 66: 237-245.

Crawford, T.L., T.T. McMillen, T.P. Meyers, and B.B. Hicks. 1993b. The spatial and temporal variability of heat, mass, and momentum air-sea exchange in a coastal environment. J. Geophysical Research, 98:12,869-12,869.

McMillen, R.T. and T.L. Crawford. 1991. Direct measurement of $CO_2$ exchange to the ocean using a ship mounted eddy correlation system. In Proc. of the 7th Conference on Meteorological Observations and Instrumentation, New Orleans, LA, American Meteorological Society, Boston, MA. Preprint Volume 2.6, pp. 46-50.

## 17.2 Journal Articles and Study Reports

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

Webb, E.K., G.I. Pearman, and R. Leuning. 1980. Correction of flux measurements for density effects due to heat and water vapor transfer. Quarterly Journal of the Royal Meteorological Society, 106:85-100.

### 17.3 Archive/DBMS Usage Documentation

None.

## 18. Glossary of Terms

None.

## 19. List of Acronyms

```
AFM     - Airborne Flux and Meteorology
ASCII   - American Standard Code for Information Interchange
ATDD    - Atmospheric Turbulence and Diffusion Division
BOREAS  - BOReal Ecosystem-Atmosphere Study
BORIS   - BOREAS Information System
CD-ROM  - Compact Disk-Read-Only Memory
CG      - Center of Gravity
DAAC    - Distributed Active Archive Center
DGPS    - Differential Global Positioning System
EOS     - Earth Observing System
EOSDIS  - EOS Data and Information System
GIS     - Geographic Information System
GMT     - Greenwich Mean Time
GPS     - Global Positioning System
GSFC    - Goddard Space Flight Center
HTML    - HyperText Markup Language
IFC     - Intensive Field Campaign
IRGA    - Infrared Gas Analyzer
```

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NAD83    - North American Datum of 1983
NASA     - National Aeronautics and Space Administration
NOAA     - National Oceanic and Atmospheric Administration
NSA      - Northern Study Area
OA       - Old Aspen
OBS      - Old Black Spruce
OJP      - Old Jack Pine
ORNL     - Oak Ridge National Laboratory
PANP     - Prince Albert National Park
PAR      - Photosynthetically Active Radiation
POD      - Processed Output Data
QA       - Quality Assurance
SSA      - Southern Study Area
URL      - Uniform Resource Locator
```

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When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

Long-EZ aircraft flux data were collected by NOAA's Atmospheric Turbulence and Diffusion Division (ATDD).

If using data from the BOREAS CD-ROM series, also reference the data as:

Crawford, T.L. and D. Baldocchi, "AFM-01: Experimental and Modeling Studies of Water Vapor, Heat and $CO_2$ Exchange over a BOREAL Forest." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

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This data set contains measurements from the AFM-1 NOAA/ATDD Long-EZ Aircraft collected during the 1994 IFCs at the SSA. These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, $CO_2$ concentration, $O_3$ concentration, and $CH_4$ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular ASCII files.

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