FIRE Marine Stratocumulus Readme

1.0 Introduction

This file contains information about the First ISCCP Regional Experiment (FIRE) Marine Stratocumulus sample read software and data files. There is read software available for these data sets. Data formats for these data sets are categorized into three groups: FIRE Standard Data Format (SDF), ASCII format, and General Processor (GENPRO) format. This readme file also includes the following five other sections:

- Section 2.0 - describes all sample C programs (source files).
- Section 3.0 - discusses how to create the executables from the C program(s).
- Section 4.0 - demonstrates how to invoke the run-time executable(s).
- Section 5.0 - provides general information on the data sets.
- Section 6.0 - provides more detailed implementation notes.

If users have questions while using the FIRE Marine Stratocumulus sample read software, please contact the Langley DAAC User and Data Services (UDS) office. The UDS may be reached by e-mail: userserv@eosdis.larc.nasa.gov, by telephone at (804)864-8656, or by FAX at (804)864-8807. The UDS mailing address is:

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Mail Stop 157D
Hampton, VA 23681-0001

2.0 Read Software Files

The sample read programs for FIRE Marine Stratocumulus data sets are developed in the C language. These C programs have been tested on the ‘Sun4 (OS 4.1.3)’ and ‘HP’ UNIX-based workstations. All library functions in the C source codes are tested for ANSI C conformance. Two files are needed to generate the read software for GENPRO data: genpro.c and fire_lib.c. Two files are used to generate the read software for National Oceanic and Atmospheric Administration (NOAA) Microwave Radiometer data: fms_mcw_rad.c and fire_lib.c. Five files are used to generate the read software for FIRE SDF data: fsdf_read.c, fire_sdf.h, fire_lib.c, fsdf_header.c, and fsdf_vtoc.c. A ‘Makefile’ (called Makefile.fms) is included for the convenience of creating the executable files from the C source files. These files and their purposes are listed as follows:

- **Makefile.fms** - contains a set of commands to build the run-time executables.
- **genpro.c** - reads GENPRO formatted data, i.e., NCAR Electra flights.

- **firesdf_read.c** - reads SDF formatted data.
- **fms_mcw_rad.c** - reads NOAA Microwave Radiometer record by record.
- **fire_sdf.h** - defines constants and data structures used in the read routines for the FIRE SDF formatted data sets.
- **fire_lib.c** - has a collection of library routines that are used by the other C source files.
- **fsdf_header.c** - parses the FIRE SDF header file and extracts the field definitions of each actual or implicit variables in the data description record (DDR) for both ancillary and observation segments.
- **fsdf_vtoc.c** -reads a record of FIRE SDF Volume Table Of Contents (VTOC).

3.0 Creating C Executable Files

The user can have two ways of building the sample read program from the C source files. One is applying the 'make' command to the file 'Makefile,' which defines the C source files listed in Section 2.0. The other is using the C compiler 'cc' (or 'acc' for Sparc ANSI C compiler). Section 3.1 illustrates the first method, and Section 3.2 illustrates the second method. The first method is simpler to use than the second one. The symbol '%' in this section stands for UNIX command line prompt.

3.1 Create with 'make' command

To build the executable files for all FIRE Marine Stratocumulus data sets, at the command line prompt, type

% **make all**

It will produce three executable files (i.e., fsdf, fms_mcw_rad, and fms_electra) for reading FIRE Marine Stratocumulus SDF, microwave radiometer, and GENPRO data, respectively. Make sure the make file name is either Makefile or makefile. If the make file has different name, e.g., Makefile.fms, type

% **make -f Makefile.fms all**

To build one of the executables, fsdf, fms_mcw_rad, or fms_electra, at the command line prompt, type:

% **make -f Makefile.fms fsdf**

% **make -f Makefile.fms fms_mcw_rad**

or, % **make -f Makefile.fms fms_electra**

Makefile defines the library file fire_lib.c and the header file fire_sdf.h to be at the same directory as the other C files. If any of these C files are not at the same directory, the definitions in the Makefile should be changed accordingly to point to the right directory. The Makefile also defines which math library should be used on your system. For example, the Makefile refers to the 'Sun4' and the 'HP' math libraries. Please uncomment the specific math library pertains to your system or insert your own math library path in the Makefile.

3.2 Create with C compiler 'cc'

This method uses the combinations of library file fire_lib.c and genpro.c, the library file and fms_mcw_rad.c, or the library file and firesdf_read.c source files. The include file fire_sdf.h should also be in the same directory. To build the executable for NCAR Electra data sets, type

% **cc -DF3_ELECTRA -o fms_electra genpro.c fire_lib.c**

to build the executable for the NOAA Microwave Radiometer data sets, type,

% **cc -o fms_mcw_rad fms_mcw_rad.c fire_lib.c**

and, to build the executable for FIRE SDF data set, type

% **cc -o fsdf firesdf_read.c fire_lib.c fsdf_header.c fsdf_vtoc.c**

NOTE that the details of C preprocessor option (-DF3_ELECTRA) are handled in the Makefile under the first method. The genpro.c program is used for FIRE Cirrus I, FIRE Cirrus II, and FIRE Marine Stratocumulus GENPRO formatted data sets. But the FIRE Marine Stratocumulus Electra data set has an extra padding of 4 bytes after every logical record, the preprocessor option is needed to skip the four bytes after every logical record.

4.0 Invoking Read Software

This section illustrates the invocation of the executable files. Section 4.1 describes how to run read program for the FIRE SDF data sets. Section 4.2 describes how to run read program for the Electra data sets. Section 4.3 describes how to run the sample read program for the NOAA Microwave Radiometer data sets.

4.1 Running Read Program for the FIRE SDF Data Sets

At this time, the executable for SDF data sets can run one data file at each invocation. The SDF read program requires three files to execute this program properly. In order to process the data file accurately, the header filename needs to be specified as the first argument, the second argument is the VTOC filename, and finally third argument is the data filename. For example, if the data file ms_noaawinds.001 is to be processed, it's corresponding header file is ms_noaawinds.hdr, and it's table of contents (VTOC) file is ms_noaawinds.toc, then type:

% **fsdf ms_noaawinds.hdr ms_noaawinds.toc ms_noaawinds.001**

fsdf will read the binary data in ms_noaawinds.001 and send the output to the standard output device. The program will then prompt the user to select which parameters to output to the standard device. The program can also run in a manner so that the output can be sent to a file by typing

% **fsdf ms_noaawinds.hdr ms_noaawinds.toc ms_noaawinds.001 num_of params param1 param2 param3 ... param# > any_file_name**

where num_of_params is the number of parameters the user would like to output to the file, and param1 ... param# are the actual list of parameters numbers to be written to the file.

See Section 6.0 IMPLEMENTATION NOTES for the SDF data output.

4.2 Running Read Program for the Electra Data Sets

Currently, the executable for Electra aircraft data sets can run one data file at each invocation. The aircraft data files are organized in pairs, i.e., one header file has a corresponding flight data file. In order to process the data file accurately, the header file needs to be specified as an argument preceding the data file argument. For example, if the data file .dat is to be processed, and its corresponding header file is RF01.hdr, then type

% **fms_electra ms_elt_flt01a_870629.hdr ms_elt_flt01a_870629.dat**

will read the binary data in RF01.dat and send the output to the standard output device. The output can be sent to a file by typing

% **fms_electra ms_elt_flt01a_870629.hdr ms_elt_flt01a_870629.dat > any_-file_name**

See Section 6.0 IMPLEMENTATION NOTES for the Electra data output.

4.3 Running Read Program for the NOAA Microwave Radiometer Data Sets

The executable for microwave radiometer data sets can accept multiple data files as the arguments. For all data sets, any error in reading the data will be written to the standard error device (i.e., stderr). The following example will read and output two microwave radiometer data files:

% **fms_mcw_rad ms_mcrw_rad_870701.hdr ms_mcrw_rad_871201.dat**

5.0 Data Sets Information

There are three subsections describing three data formats in the FIRE Marine Stratocumulus data sets. Section 5.1 describes the FIRE Marine Stratocumulus SDF data sets. Section 5.2 describes the NCAR Electra data sets in GENPRO format. Section 5.3 describes the NOAA Microwave Radiometer data sets. The data sets information are obtained from the text file or documents from the data producer. The high-level data set descriptions, the data files, the variables in the data files, and the contacts for data production are given under each data set. Some data sets contain the responses from the data producer to answer questions on the data contents. These questions/responses are collected under the NOTES ON DATA title.

5.1 FIRE Marine Stratocumulus SDF Data Sets

These data sets were written in the FIRE Standard Data Format (SDF). For a complete description of this format, please refer to the "Standard Data Format for FIRE" written by NASA Climate Data System (NCDS). Most data sets did not follow this format exactly as stated in this paper so the read program is aware of these differences. When a user orders a SDF data set, he will receive a header file, VTOC file, and an ascii representation of the first data file which ends in .001. All data experiments contain a fill value integer of 2147483647. In all cases, this value has been ignored.

In most of the experiments, you will notice in the comments that the GMT begin and end dates for each binary data file contains blanks instead of using zeroes in those positions within the ASCII header record at the top of each file or that the GMT dates were not written in the correct columns. This throws the error checking off. You will notice an error message that states that either the longitude values or latitude values are out of range. Please ignore these messages unless in the experiment comments it actually states that these values are out of range. In a couple of instances, this is true.

5.1.1 NOAA Wind Profiler

FILE NAMING CONVENTION:

ms_noaawinds.hdr (header file)

ms_noaawinds.toc (VTOC file)

ms_noaawinds.asc (ASCII representation of the first data file, .001)

ms_noaawinds.001 (first binary data file)

This data set contains 19 binary data files.

VARIABLES:

All records and parameters within this data set have been defined, including their minimum and maximum values, in the header file, ms_noaawinds.hdr.

NOTES ON DATA:

According to SDF, all binary data files should contain an ASCII header information of length of one record preceding the binary data. This does not exist in these files, therefore, refer to the VTOC file which contains the same information.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

INSTRUMENTATION:

This information is provided within the header file for this experiment.

CONTACTS FOR DATA PRODUCTION INFORMATION:

Mr. William J. Syrett

Pennsylvania State University

Department of Meteorology

503 Walker Building

University Park, PA 16802

Phone: (814) 863-2473

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5.1.2 Ceilometer and Class Sounding Data

FILE NAMING CONVENTION:

ms_ceilom_class.hdr (header file)

ms_ceilom_class.toc (VTOC file)

ms_ceilom_class.asc (ASCII representation of the first data file, .001)

ms_ceilom.001 (first binary data file - 19 binary data files)

ms_pclass.001 (first binary data file - 69 binary data files)

ms_class3.001 (first binary data file - 69 binary data files)

ms_class10.001 (first binary data file - 69 binary data files)

VARIABLES:

All records and parameters within this data set have been defined, including their minimum and maximum values, in the header file, ms_ceilom_class.hdr.

NOTES ON DATA:

There were a few modifications made to the header file as well as within the read program to work with this data set. In the header file, the minimum values for these parameters have been changed from a 1 to a 0: FNUM, RNUM, TSEQ, and DSEQ. This was done in all of the records defined in this file.

In the VTOC file, the second ceilom data file has an incorrect GMT end date of 19870707240000 when it should be 19870702240000. The DAAC could not change this date because it would affect the current binary data record file.

In the VTOC file, the 13th data file had a beginning month date within the GMT date for 01 (January) instead of 07 (July). This is also set this way in this data file as well. The DAAC could not change this date because it would affect the current binary data record file. The same applies for the begin day where it is set for the 31st and should be the 13th.

There is a parameter defined as TAL. All of the values exceed the max range defined. The data producer explained that in order to receive the correct data value, subtract 100000.0 from the real value.

The GMT date within the ASCII header record of each data file contains blanks instead of zeroes.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

INSTRUMENTATION:

This information is provided within the header file for this experiment.

CONTACTS FOR DATA PRODUCTION INFORMATION:

Paul E. Ciesielski

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Colorado State University

Fort Collins, CO 80523

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e-mail: paulc@einstein.atmos.colostate.edu

5.1.3 ER2 Lidar

FILE NAMING CONVENTION:

ms_er2_lidar.hdr (header file)

ms_er2_lidar.toc (VTOC file)

ms_er2_lidar.asc (ASCII representation of the first data file, .001)

ms_er2_lidar.001 (first binary data file)

This data set contains 79 binary data files.

VARIABLES:

All records and parameters within this data set have been defined, including their minimum and maximum values, in the header file, ms_er2_lidar.hdr.

NOTES ON DATA:

The header file states that there are 80 bytes in each data record. The last four bytes in each record are padded with zeroes.

The undetected data value has been flagged with a -9.9.

There is an integer value that appears at the end of the file. The data producer is not sure why there are a few records of this same integer appearing in every data file. The data producer has asked that we ignore this value. All data looks wonderful once this value was ignored. This integer value is 538976288. This sample read program has been written to ignore these values!

The ASCII header record does contain 160 bytes but the spacing is not the same as what has been defined in the SDF document.

The GMT date within the ASCII header record of each data file contains blanks instead of zeroes.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

INSTRUMENTATION:

This information is provided within the header file for this data set.

CONTACTS FOR DATA PRODUCTION INFORMATION:

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Room 315 Building 22
NASA/GSFC
Greenbelt, MD 20771
Phone: (301) 286-5578
e-mail: sgdlh@virl.gsfc.nasa.gov

5.1.4 CSU Radiometric and Meteorological Ground Station Data Set

FILE NAMING CONVENTION:

ms_csu_radsurf.hdr (header file)
ms_csu_radsurf.toc (VTOC file)
ms_csu_radsurf.asc (ASCII representation of the first data file, .001)
ms_csu_radsurf.001 (first binary data file)

This data set contains 20 binary data files.

VARIABLES:

All records and parameters for this data set have been defined, including their minimum and maximum values, in the header file, ms_csu_radsurf.hdr.

NOTES ON DATA:

In the header file, the minimum value for the parameter Hour Minute (HHMM) has been changed from 1 to 0.

In the header file, the maximum value for the parameter Total SW Down (SW_DOWN) has been changed from 1100 to 1200.

Throughout the data set, there are just a couple of values that exceed the maximum value defined for those parameters. The data producer is aware of these findings. For questions concerning these parameters, please contact the data producer.

The GMT date within the ASCII header record of each data file contains blanks instead of zeroes.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

INSTRUMENTATION:

This information is provided within the header file for this data set.

CONTACTS FOR DATA PRODUCTION INFORMATION:

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e-mail: hein@trueno.atmos.colostate.edu

5.1.5 CSU Tethered Balloon Platform

FILE NAMING CONVENTION:

ms_csu_tballoon.hdr (header file)

ms_csu_tballoon.toc (VTOC file)

ms_csu_tballoon.asc (ASCII representation of the first data file, .001)

ms_csu_tballoon.001 (first binary data file)

This experiment contains 6 binary data files.

VARIABLES:

All records and parameters within this data set have been defined, including their minimum and maximum values, in the header file, ms_csu_tballoon.hdr.

NOTES ON DATA:

In the header file, the minimum values for the parameters, HOUR and SECOND, have been changed from a 1 to a 0.

In the header file, the parameter name HOUR was left out of the header file as well as changing the minimum value from a 1 to a 0.

In the header file, the parameters, ROLL and PITCH, minimum and maximum values were changed from -180 to 180 to 0 to 360 degrees.

There are some other values that do fall out of the minimum and maximum ranges. If you have any questions concerning these out of range values, please contact the data producer.

All of the data files as well as the VTOC file contain the year of 1989 instead of 1987 within all GMT dates.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

INSTRUMENTATION:

This information is provided within the header file for this data set.

CONTACTS FOR DATA PRODUCTION INFORMATION:

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Phone: (303) 491-8714

FAX: (303) 491 - 8449

e-mail: hein@trueno.atmos.colostate.edu

5.1.6 United Kingdom Meteorological Office C-130 Aircraft Data Set

FILE NAMING CONVENTION:

c130_870707_13.hdr (header file)

c130_870707_13.toc (VTOC file)

c130_870707_13.asc (ASCII representation of the first data file, .001)

c130_870707_13.001 (first binary data file)

c130_870714_18.hdr (header file)

c130_870714_18.toc (VTOC file)

c130_870714_18.asc (ASCII representation of the first data file, .001)

c130_870714_18.001 (first binary data file)

This data set contains 197 binary data files.

VARIABLES:

All records and parameters within this data set have been defined, including their minimum and maximum values, in the header files, c130_870707_13.hdr and c130_870714_18.hdr.

NOTES ON DATA:

In both header files, the maximum value for the parameter, DSEQ which stands for data set Record Sequence Number, has been changed from a 99999 to a 999999.

The data started in the binary files, in the 1404 byte.

The data producer has asked to pass the information onto you that the 320th and 323rd data parameters in these data files need to be flagged as bad data. The DAAC cannot interfere with the actual data, therefore, this comment needs to be made here as well as in the read software. The read software will also inform the user of these out of range values.

There are some other values that do fall out of the minimum and maximum ranges. The data producer has asked that these data values be flagged as bad data. Please ignore these values when performing calculations. The read software will inform the user of these out of range values.

The fill value number for this data set is the maximum 4-byte integer word size of 2147483647.

The GMT date within the ASCII header record of each data file contains blanks instead of zeroes.

INSTRUMENTATION:

This information is provided within the header file for this data set.

CONTACTS FOR DATA PRODUCTION INFORMATION:

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5.2 NCAR Electra Data Set

The Electra data files for 1987 FIRE MS are provided by NCAR in GENPRO format (binary positive integers). The data files are organized in pairs for an individual flight, i.e., header #1, flight #1 data, header #2, flight #2 data, etc... Header files are in ASCII format, and flight data are in binary format.

FILES:

Electra data sets have 29 header-data-file pairs for 10 flights. All but flight 9, which has two, have three header-data-file pairs. Each flight is named ms_elt_flt#X_flighttime, where # ranges from 01 to 10, X is one of a, b or c (except flight 09 has only a and b), and "flighttime" has the format of yymmdd to indicate the date of the flight, e.g., ms_elt_flt07b_870711. The flight name is the same as the granule name. The header files are named granule_name.hdr, and the data files are named granule_name.dat.

A header file contains the variable names (or called parameters), and the information regarding sampling rate, scale factors, data size, etc. for the parameters. The data file contains data values of parameters over a specified time period.

VARIABLES:

Each of the Electra data record has 183 variables. Each variable is defined as a 4 bytes unsigned integer. The unsigned integer values have to be converted to real numbers for correct reading. Usually the variables are sampled at 1 Hz per second (per genpro cycle), but some variables are sampled at higher rate. The sample read routine automatically retrieves the information for all defined parameters, and interprets the binary data accordingly.

NOTES ON DATA:

Questions about instrumentation and specific data parameters (including their derivation, utilization and units) should be directed to NCAR.

CONTACTS FOR DATA PRODUCTION INFORMATION:

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5.3 NOAA Microwave Radiometer Data Set

NOAA Microwave Radiometer data were taken during the FIRE Marine Stratocumulus Experiment at SAN NICOLAS ISLAND site. Data were collected during the period from July 1, 1987 to July 19, 1987. These data sets contained information regarding vapor and liquid.

FILES' NAMING CONVENTION:

ms_mcrw_rad_yymmdd (where yymmdd is the date ranging from 870701 to 870719)

VARIABLES:

Each data file has the format of header lines and data records. Each of the microwave radiometer record contains three variables: time, vapor, and liquid.

6.0 Implementation Notes

6.1 FIRE SDF program

The fsdf_header.c program builds the data structure for the variables defined in the Variable Description (VD) record. When the variables values are to be displayed as octal, or hexadecimal format, the scaling constant 'b' of the conversion function defined in the VD record is stored as 0 for the convenience of coding (the header file is not changed). It is assumed these variables requires no conversion from integer to floating point values.

FIRE SDF rules recommend the bad or missing data to be represented by the largest possible integer value for each data type, but some data sets use the different values as the fill value. This sample read program knows what these fill values are and are identified in the code.

This standard read program is capable to read in a SDF file that is available at the Langley DAAC. Because of all of the modifications made in this read program to handle the SDF data files, this program could not read any other SDF files not available here at the Langley DAAC.

This read software reads in all of the information defined in the header file such as the min/max ranges for every parameter, what values are needed to convert the value to a real number, as well as how many parameters are in each record defined. The program prints these parameters onto the screen and the user is able to select those parameters he wishes to print. Currently, the values will be printed out to the screen. The user may redirect his output to another file or modify the program to write out the data in a different presentation and file.

6.2 GENPRO program

The generic read program (genpro.c) for FIRE aircraft flight data extracts the flight date, flight start time, and flight end time from the header file (not from the data file) because FIRE-I Kingair flight data do not have the time variables (HR, MIN, SEC) defined like other aircraft data. However, the minimum and maximum INS (Inertial Navigation System) latitude and longitude values are obtained from the data file. The total number of records in the specified data files is printed out at the end of the output.

Because of the huge amount of data in the data file, the read program by default only prints out the selected 7 variables (1st, 2nd, 3rd, 4th, 5th, 6th, and 7th variables, in that order) of all records in tabular format. The "printf" statement in the C source file works as a demonstration of printing out values of the desired variables. If all data values are to be printed out, users should re-compile the genpro.c program with a "-DDEBUG" preprocessor option and rerun the executable. The minus D option will produce the values of all variables for all records in the specified data file.

APPENDIX

A-1: Output from running 'make all' on HP workstation

The following is the output from running makefile to build FIRE Marine Stratocumulus on HP:

HP% make -f Makefile.fms all

```
cc -O -Aa   -I.   -c  fms_lib.c

rm -f ./lib_fms.a

ar rlv ./lib_fms.a `lorder fms_lib.o | tsort`

a - fms_lib.o

ar: creating ./lib_fms.a

ranlib ./lib_fms.a

ranlib: ar already did it for you, see ar(1).

rm -f fms_electra

cc -O -Aa   -I.    -DFMS_ELECTRA -o fms_electra genpro.c ./lib_fms.a

cc -O -Aa   -I.   -c  firesdf_read.c

cc -O -Aa   -I.   -c  fsdf_header.c

cc -O -Aa   -I.   -c  fsdf_vtoc.c

rm -f fsdf

cc -O -Aa   -I.    -o fsdf firesdf_read.o  fsdf_header.o  fsdf_vtoc.o ./lib_fms.a -lm

rm -f fms_mcw_rad

cc -O -Aa   -I.    -o fms_mcw_rad fms_mcw_rad.c ./lib_fms.a
```

A-2: Output from running 'make all' on SUN4 workstation:

The following is the output from running makefile to build FIRE Marine Stratocumulus on SUN:

SUNOS% make -f Makefile.fms all

acc -O -I. -sun4 -c fire_lib.c

rm -f lib_fire.a

ar rlv lib_fire.a 'lorder fire_lib.o | tsort'

a - fire_lib.o

ar: creating lib_fire.a

ranlib lib_fire.a

rm -f fms_electra

acc -O -I. -sun4 -DFMS_ELECTRA -o fms_electra genpro.c ./lib_fire.a

acc -O -I. -sun4 -c firesdf_read.c

acc -O -I. -sun4 -c fsdf_header.c

acc -O -I. -sun4 -c fsdf_vtoc.c

rm -f fsdf

acc -O -I. -sun4 -o fsdf firesdf_read.o fsdf_header.o fsdf_vtoc.o ./lib_fire.a /usr/lib/libm.a

rm -f fms_mcw_rad

acc -O -I. -sun4 -o fms_mcw_rad fms_mcw_rad.c ./lib_fire.a