SOLAR-A REFORMATTED DATA FILES AND OBSERVING LOG*

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Abstract. All of the SOLAR-A telemetry data will be reformatted before distribution to the analysis computers and the various users. This paper gives an overview of the files which will be created and the format and organization which the files will use. The organization has been chosen to be efficient in space, to ease access to the data, and to allow for the data to be transportable to different machines. An observing log file will be created automatically using the reformatted data files as the input. It will be possible to perform searches with the observing log to list cases where instruments are in certain modes and/or seeing certain signal levels.

1. Introduction

It is universally recognized that solar research, and especially flare studies, profit greatly from coordinated analysis of different types of observational data. Yet, in the past, little preplanning of data formatting and archiving has been done to facilitate joint analysis. Each experimenter tended to act independently, solving their own analysis and archiving problems in their own way. Data have been formatted and stored in a plethora of formats and media. Those data in digital form, and thus presumably universally available, reside in incompatible machines addressable only with specialized, esoteric software. Often the comparison of results has been seriously impeded. Joint analyses, other than the most qualitative comparisons, have been accomplished with great difficulty and in a sadly limited number of cases.

The SOLAR-A investigators have determined to do better. It has been decided to produce a common reformatted data base for all of the SOLAR-A experiments for

* After the launch the name of SOLAR-A has been changed to YOHKOH.

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distribution to all of the investigators. This will be produced with a synoptic file structure to ease access for scientific analysis and in a form as transportable as possible between computers with different operating systems. In the end, this work may be as important to the scientific productivity of the mission as the capabilities of the SOLAR-A instruments.

2. SOLAR-A Data Flow

The SOLAR-A data will be received by the Kagoshima Space Center (KSC) station in Japan, and by several NASA Deep Space Network (DSN) stations around the world (Canberra, Goldstone, and Madrid). The spacecraft uses a bubble data recorder (BDR) to store the data when a real-time station downlink is not available. The 10 Mbyte capacity of the BDR can store 40 min of high rate (32 kbps) data. There will be 5 downlinks to KSC every day plus four to ten downlinks to the DSN stations. The KSC data is available in real time; the DSN data could take up to two or three days before being available. All of the SOLAR-A raw telemetry data will be time-ordered and stored on-line in the large SIRIUS data base at the Institute of Space and Astronautical Sciences (ISAS). The maximum data telemetered down is 4.7 Gigabyte per month. The SOLAR-A reformatter will work from this data base.

The SOLAR-A reformatter will run on a Unix workstation at ISAS. The reformatter will be written in Interactive Data Language™ (IDL) Version 2.0 which is available from Research Systems, Inc. We intend to create data files that are portable and which can be read on any machine. The information necessary to tell the user how to read the file are present in the beginning of each data file. That information along with a copy of the SOLAR-A File Control Document should allow any user to access the data. The reformatter will create seven files as follows:

BCS	Bragg Crystal Spectrometer;
HXT	Hard X-ray Telescope;
SXT–PFI	Soft X-ray Telescope/Partial Frame Images;
SXT–FFI	Soft X-ray Telescope/Full Frame Images;
WBS	Wide-Band Spectrometer;
ATT	Spacecraft Attitude Data;
CBA	Spacecraft Common Basic Part.

The first five files contain the data from the scientific instruments. A complete copy of the raw spacecraft attitude data will be available in the ATT file. This will be the first file created and the reformatter will use this file to generate processed pointing information which will be included with each scientific data set entry. The CBA section contains a complete duplicate copy of the spacecraft common 'Basic Part' data. This is for possible unanticipated use in the future as we intend that all necessary information in this section of telemetry has been included in the respective scientific data files. The reformatted data files will initially be distributed on 8 mm tapes, about 1 such tape per week. We hope eventually to archive the data on CD-ROM.

3. Organization and Format of Reformatted Data Files

The data files are a simple stream of bytes, organized to allow direct access into the data file. The data is padded where necessary in order to package the data such that Vax VMS™ can use fixed records (probably 16 bytes long). Unix allows the user to directly access any byte and does not use record structures. This organization should allow us to maintain full compatibility between a large variety of machines.

The data files make full use of the structure data types which are available in FORTRAN (Vax and Sun™ FORTRAN extensions) and IDL. Each structure has a version number associated with it so structures can be changed and expanded without requiring difficult changes to the access software. Full flexibility to expand structures and add structures allows the user to maintain a full history of what processing has been done to the data. In addition to the raw reformatted data files, all processed data files will follow the same organization in order to allow existing software routines to display, analyze and process those new files.

The organization of the files is illustrated in Table I. Its sections will now be discussed in turn.

File pointer and information section. The first section in the file contains information needed to read the file. It contains pointers to the start of all of the major sections (file header, quasi-static index, data, optional data, and road map). It also contains information on what machine convention was used for integer and real variables, the file organization used, and the VMS record length. There are also two fields which hold sample integer and real values to confirm that any routine used for conversion between machine representations is working correctly.

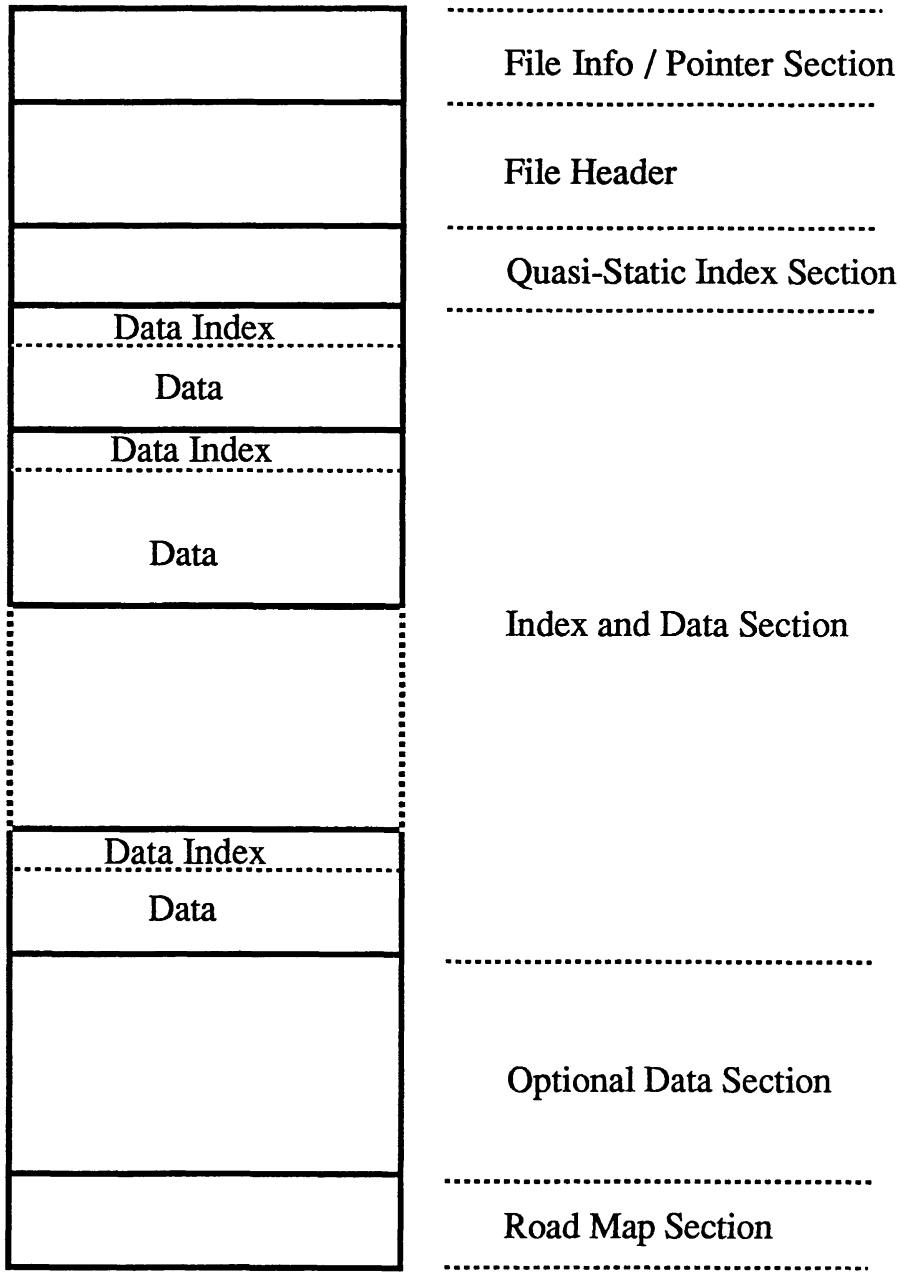
File header section. The file header section contains information on what data is present in the file. Information about the range of dates and times covered, the program that created the file, the time and date that the data file was created, the total number of data sets, the machine that created the file, the spacecraft and instrument, the number of quasi-static index entries, and other similar information is contained in this section.

Quasi-static index section. The quasi-static index section is used to provide calibration and scientific data conversion information. The data present in this section seldom changes and does not need to be duplicated in each data index section. Information such as detector gain, coefficients for converting temperature and voltage, instrument pointing offsets, information on versions used for certain algorithms, etc., are included here.

Index and data section. The data are broken up into data sets, and each data set has an index section and a data section. The data are broken up by modes for SXT and BCS (WBS and HXT provide a continuous stream of data and do not have modes).

BCS	One data set per spectra.
HXT	One data set per telemetry major frame.
SXT	One data set per image exposure.
WBS	One data set per 2 telemetry major frames.

TABLE I
SOLAR-A reformatted files



The data index section will contain the information necessary to analyze the data. Information on the data word type (byte, integer, real), the amount and quality of the data, the data compression, the instrument mode, the status of instrument peripheral hardware (filters, door positions, etc.), temperatures, spacecraft pointing, and spacecraft mode, rate, and flare status.

The data index section can be expanded with a variety of structures to reflect data processing performed on the data saved in the file. A full history of the data processing can be maintained in this manner. The data described in the data index section immediately follows the data index section.

Optional data section. Some instruments require an additional data section to provide a complete copy of the telemetry data. The BCS spectral data comes down asynchronously, but there is other synchronous information available. For simplicity, a complete copy of the synchronous BCS data is available in the optional data section. For HXT, there are two one-dimensional arrays used to find the limb of the Sun. This data comes down at a different telemetry cadence and will be placed in the optional data section. SXT and WBS do not use the optional data section.

Road map section. The final section contains a short summary of each of the data sets available in the file and a pointer to the beginning of each data set. The section gives information on the instrument mode and a brief summary of the data (e.g., average or total counts). This section is almost an exact duplicate of the observing log entry, which is described in Section 4.

4. Log Files

A program will use the reformatted data files from the scientific instruments and create an observing log. This log will be produced automatically with little or no human interaction. Other log files will also be created using the reformatted data and the observing log as input. Some of these logs will require user interaction.

The observing log will provide a full summary of the modes and data available for each of the SOLAR-A instruments. There will be one entry for each SXT image, a BCS entry for each spectra (but not more often than every 4 s), and an entry every 2 major frames (every 4 s during high telemetry rate) summarizing the WBS and HXT count rates and modes. Information on the spacecraft orbital solutions, the reformatted data file IDs, and conversion coefficients are also provided in this log. A single file will contain the log for one month which should be about 30 Mbyte.

A user will be able to search the observing log and obtain a list of all cases where a given set of conditions are satisfied. For example, one could search for occasions when a certain mode occurs or when the signal was above a certain threshold. The user could cross reference to other instruments to select only cases where several instruments were in a given mode seeing a particular count level. It is possible that a similar log will eventually be generated with information on what ground-based instruments were in operation and the data available from that instrument. It will also be possible to create light curves from the instrument count rates with a time resolution of about 4 s.

An event log will be created listing the times when the instrument or spacecraft modes change. The event log will be generated from the observing log, but will be much smaller since it only logs changes in modes and will not contain information about the data count levels. Because of the small size, this log could easily contain several years of information and would remain readily transportable to machines with limited disk space.

A flare and active region log is contemplated. This log will require a user to identify which regions should be included. The log will probably contain information on which instruments saw that region at what times, and the mode that the instrument was in. Ground-based observations could also be incorporated into this log.

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