## 2.0 Level 1b Data Base

This section describes the NOAA Polar Orbiter Level 1b Data Base that is archived by SSB, and from which users may request data.

Level 1b (following FGGE terminology) is raw data that have been quality controlled, assembled into discrete data sets, and to which Earth location and calibration information have been appended (but not applied).

The data are present on the data base as a collection of data sets. Each data set contains data of one type for a discrete time period. Thus, there are separate HRPT, LAC, GAC, HIRS, MSU, and SSU data sets. Time periods are arbitrary subsets of orbits, and may cross orbits (i.e., may contain data along a portion of an orbital track that includes the ascending node, the reference point for counting orbits). Generally, GAC, HIRS, MSU, and SSU data sets will be available for corresponding time periods and usually have a three to five minute overlap between consecutive data sets.

Prior to June 1981, the Earth location data in the AVHRR and TOVS Level 1b data may have been slightly inaccurate due to errors in the TIROS Information Processor (TIP) clock onboard the spacecraft. The 6-byte time code in the Level 1b data is taken from the TIP clock which routinely contained errors of 1.5 to 2.3 seconds.

Some problems have been encountered with NOAA-10 and NOAA-11 AVHRR Level 1b GAC data in regards to earth locations, distances between adjacent scan lines, data gaps, scan line numbers, and out of sequence scan times. It is not known at this time if these problems existed with the earlier spacecraft in the TIROS-N series. NESDIS/IPD is investigating these problems and will take corrective action. The following paragraphs summarize a memorandum from Karl W. Cox (SMSRC) to Pat Mulligan (NOAA/NESDIS/OSD) which details the problems. Copies of this memorandum are available from SSB.

As the spacecraft moves through its orbit, the expected angular distance between the nadir of adjacent GAC scans is approximately 0.0296 degrees of arc, or 3.2914 km, as measured from the center of the earth. This actual value of the average angular distance can vary by up to about 0.1712 km due to variations in satellite height, scan angle and other factors. Forty-eight randomly selected NOAA-10 and NOAA-11 GAC data sets were examined over a period of a few days at the beginning of July 1990. On the average, the distances between adjacent scan lines were outside the permitted window (+/-0.2304 km) 45 times per dataset. The time difference between these adjacent scan lines was the expected 500 milliseconds, but the quality flags did not indicate a data gap.

When data gaps occur in GAC data, the scan line number is supposed to be incremented to reflect the number of scan lines corresponding to the length of the gap. However, the first scan line after a data gap was found to have the scan number next in sequence of those preceding the gap, while the second scan line following the gap had been incremented by the number of scan lines corresponding to the data gap. On an average, data gaps were found to occur two to three times per dataset with the gaps typically ranging from one to 40 scan lines.

In four out of the 48 GAC data sets examined, scan times were encountered which were not in proper sequence. Some of the time differences were very large. This problem introduces earth locations markedly different from those of adjacent scan lines. However, the scan line numbers were in ascending sequence as if there were no problems with the scan times or earth locations, and no scan quality flags had been set.

In the past, SSB has attempted to give the user only data with calibration information, but it was found that most users preferred to receive all the data (with or without calibration information) over their area and/or time span. The user can then use his discretion in applying the calibration coefficients to any gaps of data without calibration information. **It is SSB's policy that all Level 1b data (whether it includes calibration information or not) will be provided to the user for his specific area or time unless explicitly requested otherwise by the user.**

In the event that the user receives data without calibration information, the data can be calibrated from the telemetry information contained in each scan. For a detailed explanation of this procedure, refer to NOAA Technical Memorandum NESS 107 entitled *Data Extraction and Calibration of TIROS-N/NOAA Radiometers*, available from SSB. In the case of a data set with some calibration present, the user can usually interpolate the calibration data between known points for the uncalibrated portion.

### 2.0.1 Clock Information

Users of Level 1b data should be aware that the satellite's on board clock experiences a small drift in time over a period of several months. Specifically, that time drift can be defined by $\Delta t$ , where $\Delta t$ is the spacecraft clock time (t) minus the actual UTC time. SOCC monitors this time error and maintains $\Delta t$ to within +/- 0.5 seconds. The Earth location data which is appended to the Level 1b data is based on the spacecraft clock time. Therefore, an error in $\Delta t$ will be reflected as an error in Earth location. The error in Earth location due to this timing error could be as much as 4 kilometers at the satellite subpoint. SOCC normally applies the time correction around 2359 UTC on the scheduled date. The clock error, drift rate, last update and future update are announced in the APT Predict Bulletin (TBUS - TIROS Bulletin U.S.). The Level 1b process has been enhanced to incorporate a clock drift correction option. See Appendix L for details. Figure 2.0.1-1 shows a typical drift of $\Delta t$ (note that points A and B are where SOCC applies the correction to $\Delta t$).

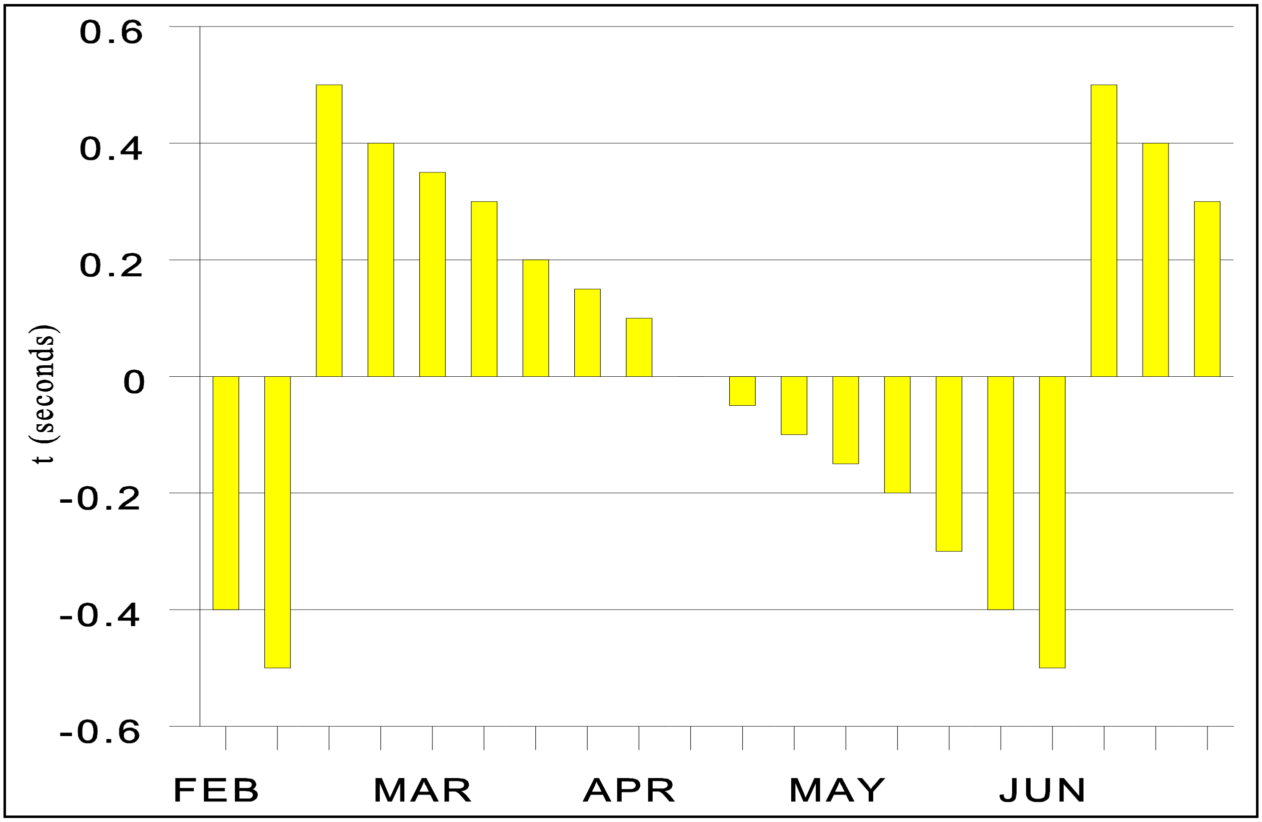


**Figure 2.0.1-1. Typical Time Drift Δt**

2.0.2 **IBM Conventions**

All the NOAA polar orbiter Level 1b data and products are produced on IBM mainframes. This section describes some of the characteristics of data written on an IBM mainframe. The bit and byte numbering conventions are described, in addition to the representations for signed binary integers and floating point numbers. These conventions are especially critical if the user does not use an IBM machine to read the data. This does not imply that these data cannot be read on non-IBM machines, but the user should exercise some caution when reading "IBM-generated" data on a non-IBM machine.

The bit and byte (one byte equals 8-bits) numbering convention for Level 1b data sets is as follows. The bits within each byte or word are numbered from the most significant bit (MSB) on the left to the least significant bit (LSB) on the right, with the MSB identified as bit 31, the next most significant as bit 30, and with the LSB as bit 0. Similarly, the byte containing the 8 MSBs of a 32-bit word is identified as byte 4; and the byte containing the 8 LSBs, as byte 1.

IBM's signed binary integers are usually represented as halfwords (16 bits) or words (32 bits). In both lengths, the leftmost bit (bit 31) is the sign of the number. The remaining bits (bits 1-15 for halfwords and 1-31 for words) are used to designate the magnitude of the number. Binary integers are also referred to as fixed-point numbers, because the radix point (binary point) is considered to be fixed at the right, and any scaling is done by the programmer.

Positive binary integers are in true binary notation with a zero sign bit. Negative binary integers are in two's-complement notation with a one bit in the sign position. In all cases, the bits between the sign bit and the leftmost significant bit of the integer are the same as the sign bit (that is, all zeros for positive numbers, all ones for negative numbers). Negative binary integers are formed in two's-complement notation by inverting each bit of the positive binary integer and adding one.

A floating point number is expressed as a hexadecimal fraction multiplied by a separate power of 16. The term floating point indicates that the placement, of the radix (hexadecimal) point, or scaling, is automatically maintained by the machine.

The part of a floating-point number which represents the significant digits of the number is called the fraction. A second part specifies the power (exponent) to which 16 is raised and indicates the location of the radix point of the number. The fraction and exponent may be represented by 32 bits.

A floating-point number has two signs: one for the fraction and one for the exponent. The fraction sign, which is also the sign of the entire number, is the leftmost bit of each format (0 for plus, 1 for minus). The numeric part of the fraction is in true notation regardless of the sign. The numeric part is contained in bits 8-31.

The exponent sign is obtained by expressing the exponent in excess-64 notation; that is, the exponent is added as a signed number to 64. The resulting number is called the characteristic. It is located in bits 1-7. The characteristic can vary from 0 to 127, permitting the exponent to vary from -64 through 0 to +63. This provides a scale multiplier in the range of $16^{-64}$ to $16^{+63}$. A nonzero fraction, if normalized, has a value less that one and greater than or equal to 1/16, so that the range covered by the magnitude of a normalized floating-point number is between $16^{-65}$ and $16^{+63}$.

### 2.0.3 <u>**Level 1b Data Set Names**</u>

This section describes the data set naming convention which is used for all Level 1b data sets. Each data set has a unique data set name which is generated when the data set is created. This 42-character name (which is coded in binary coded decimal [BCD]) will be used to reference the data sets. The data set name will be "NSS" followed by a set of alphanumeric qualifiers separated by periods (.). The complete data set name with all its qualifiers will be as follows:

NSS.DATA-TYPE.SPACECRAFT-UNIQUE-ID.YEAR-DAY.START-TIME.STOP-TIME.PROCESSING-BLOCK-ID.SOURCE

The qualifiers of the data set name are shown in Table 2.0.3-1.

| Table 2.0.3-1. Data set name qualifiers. | |
|---|---|
| **Qualifier** | **Example** |
| DATA-TYPE | Valid groups are:<br>HRPT= HRPT (direct readout full resolution AVHRR)<br>GHRR= GAC (recorded reduced resolution AVHRR)<br>LHRR= LAC (recorded HRPT AVHRR)<br>HIRX= HIRS/2 data set derived from GAC embedded TIP<br>MSUX= MSU data set derived from GAC embedded TIP<br>SSUX= SSU data set derived from GAC embedded TIP<br>HIRS= HIRS/2 data set derived from stored TIP<br>MSUS= MSU data set derived from stored TIP<br>SSUS= SSU data set derived from stored TIP |
| SPACECRAFT-UNIQUE-ID | TIROS-N = TN<br>NOAA-A = NA = NOAA-6<br>NOAA-B = NB<br>NOAA-C = NC = NOAA-7<br>NOAA-D = ND = NOAA-12<br>NOAA-E = NE = NOAA-8<br>NOAA-F = NF = NOAA-9<br>NOAA-G = NG = NOAA-10<br>NOAA-H = NH = NOAA-11<br>NOAA-I = NI = NOAA-13<br>NOAA-J = NJ = NOAA-14 |
| YEAR-DAY | D76104, where "D" identifies this group as a Julian day delimiter, "76" identifies the year in which the spacecraft began recording the data set and "104" identifies the Julian day on which the spacecraft began recording the data set. |
| START-TIME | S1355, where "S" identifies this group as a start time delimiter. "1355" denotes 13 hours 55 minutes UTC (to the nearest minute) and represents the time at which spacecraft recording began. |
| STOP-TIME | E1456, where "E" identifies this group as an end time delimiter. "1456" denotes 14 hours 56 minutes UTC (to the nearest minute) and represents the time of spacecraft recording of the last usable data in the data set. |
| PROCESSING-BLOCK-ID | B0016465, where "B" identifies this group as a processing block ID delimiter. "0016465" is a seven digit number identifying the spacecraft revolution in which recording of this data set began and the revolution in which the data was transmitted to ground (the first five digits identifying the beginning revolution and last two being the two least significant digits of the orbit number identifying the readout revolution). However, NESDIS does not necessarily guarantee that the Processing-Block-ID contains the correct beginning and ending orbit number. Frequently (especially with LAC data), the orbit numbers are 1 to 2 off the correct orbit; thus, it is always prudent when ordering data to include a time, if |

| | |
|---|---|
| | known. |
| SOURCE | Valid character groups are:<br>Fairbanks, Alaska (formerly Gilmore Creek) = GC<br>Western Europe CDA = WE<br>SOCC (Satellite Operations Control Center) = SO<br>Wallops Island, Virginia = WI |

## 2.0.4 Data Set Header

This section describes the Data Set Header. **All** Level 1b data sets (with the exception of the SBUV/2) contain a Data Set Header record describing the data set. This header record is in binary and padded with trailing spare bytes to make it the same size as the full channel data set records. (Note: The Data Set Header for HRPT and LAC data sets is contained in **two** 7400-byte records. The first record contains the Data Set Header as described below and the second record will be meaningless to the user.) Currently, there are two slightly different Data Set Headers: one for the AVHRR and one for the TOVS data. The Data Set Header for TOVS has changed slightly from the original. Its format is given in Table 2.0.4-1.

**Table 2.0.4-1. Data set Header Record Format for TOVS (after September 8, 1992)**.

| Byte # | # Bytes | Content |
|---|---|---|
| 1 | 1 | Spacecraft ID |
| 2 | 1 | Data Type |
| 3-8 | 6 | Start Time |
| 9-10 | 2 | Number of scans |
| 11-16 | 6 | End Time |
| 17-23 | 7 | Processing Block ID (ASCII) |
| 24 | 1 | Ramp/Auto Calibration |
| 25-26 | 2 | Number of Data gaps |
| 27-32 | 6 | DACS Quality |
| 33-34 | 2 | Calibration Parameter ID |
| 35 | 1 | DACS Status |
| 36 | 1 | Reserved for mounting and fixed attitude correction indicator:<br>0 = no correction applied<br>1 = correction applied |
| 37 | 1 | Nadir earth location tolerance. Integer scaled to 0.1 km, values range from 0.1 to 25.5 km. |
| 38 | 1 | Spare (Zero-filled) |
| 39-40 | 2 | 4-digit year for start of data (effective December 2, 1998) |
| 41-82 | 42 | 42 character dataset name (EBCDIC) |
| 83-84 | 2 | Blank-filled |
| 85-end | variable | Zero-filled with enough bytes to make Header Record |

| | | |
|---|---|---|
| | | same size as data record. |

SSB uses specialized software to extract parts of Level 1b datasets, based on user=s selection criteria (channel, area and/or time selects). As of July 3, 1996, SSB modified the extraction software so that the Data Set Header record would reflect the **actual** number of output scan lines within the subsetted dataset and not the total number of scan lines found in the original dataset. This change does not affect users who order tape copies of entire datasets, just the users that order extracts.

The Data Set Header format was modified on two different occasions: Sept. 8, 1992 and Nov. 15, 1994. Appendix K contains the original format (before Sept. 8, 1992) of the Data Set Header, while Appendix L contains the interim format (between Sept. 8, 1992 and Nov. 15, 1994) of the Data Set Header.

The current Data Set Header format for AVHRR data includes orbital parameters that were implemented with other enhancements on Nov. 15, 1994. The format for the AVHRR Data Set Header is given in Table 2.0.4-2.

**Table 2.0.4-2. Data Set Header record format for AVHRR (after Nov. 15, 1994).**

| Byte # | # of bytes | Contents | Scaling Factor |
|---|---|---|---|
| 1 | 1 | Spacecraft ID | n/a |
| 2 | 1 | Data Type | n/a |
| 3-8 | 6 | Start Time | n/a |
| 9-10 | 2 | Number of scans | n/a |
| 11-16 | 6 | End Time | n/a |
| 17-23 | 7 | Processing Block ID (ASCII) | n/a |
| 24 | 1 | Ramp/Auto Calibration | n/a |
| 25-26 | 2 | Number of data gaps | n/a |
| 27-32 | 6 | DACS Quality | n/a |
| 33-34 | 2 | Calibration Parameter ID | n/a |
| 35 | 1 | DACS Status | n/a |
| 36 | 1 | Reserved for mounting and fixed attitude correction indicator:<br>0 = no correction applied<br>1 = correction applied | n/a |
| 37 | 1 | Nadir earth location tolerance. Integer scaled to 0.1 km, values range from 0.1 to 25.5 km. | n/a |
| 38 | 1 | Spare (Zero-filled) | n/a |
| 39-40 | 2 | 4-digit year for start of data (effective December 2, 1998) | n/a |
| 41-84 | 44 | 44 character dataset name (EBCDIC) | n/a |
| 85-86 | 2 | 2-digit year of Epoch for orbit vector (4-digit year effective December March 17, 1999) | n/a |

| | | | |
|---|---|---|---|
| 87-88 | 2 | Julian Day of Epoch (XXX) | n/a |
| 89-92 | 4 | Millisecond UTC epoch time of day (XXXXXXXX) | n/a |
| **Keplerian Orbital Elements** | | | |
| 93-96 | 4 | Semi-major axis in kilometers | 1000 |
| 97-100 | 4 | Eccentricity | 100000000 |
| 101-104 | 4 | Inclination (in degrees) | 100000 |
| 105-108 | 4 | Argument of Perigee (in degrees) | 100000 |
| 109-112 | 4 | Right Ascension of the Ascending Node (in degrees) | 100000 |
| 113-116 | 4 | Mean Anomaly (in degrees) | 100000 |
| **Cartesian Inertial True of Date Elements** | | | |
| 117-120 | 4 | x component of position vector (in kilometers) | 10000 |
| 121-124 | 4 | y component of position vector (in kilometers) | 10000 |
| 125-128 | 4 | z component of position vector (in kilometers) | 10000 |
| 129-132 | 4 | x -dot component of position vector (in kilometers) | 1000000 |
| 133-136 | 4 | y -dot component of position vector (in kilometers) | 1000000 |
| 137-140 | 4 | z -dot component of position vector (in kilometers) | 1000000 |
| **Future Use** | | | |
| 141-142 | 2 | Yaw fixed error correction | n/a |
| 143-144 | 2 | Roll fixed error correction | n/a |
| 145-146 | 2 | Pitch fixed error correction | n/a |
| 147-end | variable | Spares - zero filled to the size of the data record | n/a |
| Note: orbit parameters are scaled to 4-byte integers (not 8-byte floating point). | | | |

Valid **spacecraft IDs** are contained in Table 2.0.4-3. Note that the spacecraft ID is identical for NOAA-11 and TIROS-N. In this case, users should use the time code in conjunction with the spacecraft ID to verify that they have the correct satellite.

**Table 2.0.4-3. Spacecraft ID**.

| ID Number | Satellite |
|---|---|
| 0 | Spare |
| 1 | TIROS-N |
| 2 | NOAA-6 |
| 4 | NOAA-7 |
| 6 | NOAA-8 |
| 7 | NOAA-9 |
| 8 | NOAA-10 |
| 1 | NOAA-11 |
| 5 | NOAA-12 |
| 2 | NOAA-13 |
| 3 | NOAA-14 |

The **data type** of the data set is identified by the two integer codes contained in Table 2.0.4-4.

**Table 2.0.4-4. Data Type Codes.**

| Bits 4-7 | | Bits 0-3 | |
|---|---|---|---|
| **Code** | **Data Type** | **Code** | **TIP Source** |
| 1 | LAC | 1 | Embedded TIP |
| 2 | GAC | 2 | Stored TIP |
| 3 | HRPT | 3 | Third CDA TIP |
| 4 | TIP | 4-15 | Spare |
| 5 | HIRS/2 | n/a | n/a |
| 6 | MSU | n/a | n/a |
| 7 | SSU | n/a | n/a |
| 8 | DCS | n/a | n/a |
| 9 | SEM | n/a | n/a |
| 10-15 | Spare | n/a | n/a |

The **start time** is the spacecraft time code from the first frame of data processed for this data set and is contained in 6 bytes. The year is contained in the leftmost 7 bits of the first two bytes, the 9-bit Julian day is right-justified in the first two bytes, and the 27-bit millisecond UTC time of day is right-justified in the last four bytes. All other bits are zero. Figure 2.0.4-1 shows the format of the time code for both start and end times. Complete scans that fall within data gaps are not included in the **number of scans** count. A gap in the data that covers one or more consecutive scans is counted as one data gap.

```
 Byte n    Byte n+1  Byte n+2  Byte n+3  Byte n+4  Byte n+5
| . . . . . . . | . . . . . . . | . . . . . . . | . . . . . . . | . . . . . . . | . . . . . . . |
|<-Year>|<--Julian->|        |<---UTC time (milliseconds)----->|
                   Day
 (7 bits)    (9 bits)                          (27 bits)
```

**Figure 2.0.4-1. Format of the Time Code for both Start and Stop Times**

The **end time** is the spacecraft time code from the last frame of data processed for this data set. The content and format are the same as described for the start time (see Figure 2.0.4-1).

The **Processing Block ID** is a seven-byte field generated from start and end times. It contains the spacecraft revolution in which recording of the data set began and the revolution in which it terminated (same as the Processing Block ID described in beginning of Section 2.0.3).

The **ramp/auto calibration** field is contained in one byte. Bits 4-8 of this byte have meaning for GAC, LAC, and HRPT data sets only. These bits indicate ramp non-linearity. Bit 3 of this byte has meaning only for HIRS/2 and SSU data sets and contains the setting of the auto calibration override switch. Bit 4 is used for channel 1, bit 5 for channel 2, etc.

The **DACS quality field** consists of six types of DACS (Data Acquisition and Control Subsystem) quality information accumulated in the headers of all data sets derived from data input from DACS. The first two bytes contain a count of the input data frames that contained no frame sync word errors. The second two bytes contain a count of the DACS detected TIP parity errors. The last two bytes contain a sum of all auxiliary sync errors detected in the input data for the complete data set.

The **calibration parameter ID** identifies the calibration parameter input data set which is used to calibrate the data in this data set. The ID is encoded internally as a string of two 8-bit characters; not as an integer number.

**DACS status** information comprises one byte and is contained in the header of all data sets derived from data input from DACS. This byte is described in Table 2.0.4-5.

**Table 2.0.4-5. DACS Status Information Format**.

| Bits | Value | Meaning |
|---|---|---|
| 7 | Pseudo Noise (P/N) Flag | |
| | 0 | Normal Data |
| | 1 | P/N Data |
| 6-5 | Data Source | |
| | 0 | Unused |
| | 1 | Fairbanks |
| | 2 | Wallops |
| | 3 | SOCC |
| 4 | Tape Direction | |
| | 0 | REV (time decrementing) |
| | 1 | FWD (time incrementing) |
| 3 | Data Mode | |
| | 0 | Test Data |
| | 1 | Flight Data |
| 2-0 | Spare | |

## 2.1 Level 1b Tape Formats

This section describes the general structure of a magnetic tape containing Level 1b data. Section 2.1.1 describes the record and file arrangement of Level 1b data tapes. For information regarding the data format of a specific type of Level 1b data, see Section 3 for AVHRR data and Section 4 for TOVS data.

SSB offers the user data written on several different types of magnetic media. These media include IBM 3480 cartridges, 4 mm DAT tapes and 8 mm Exabyte tapes. (Nine-track 800, 1600 and 6250 BPI tapes are no longer available.)

There are also several selection options available to the user. It is possible to obtain a full data set copy, or just a portion of a data set (specified by an area and/or time). In addition, channels can also be selected and the data can be unpacked. (Selection of data by channels automatically results in data which is in the 16-bit unpacked format.)

SSB uses specialized software on all Level 1b data (except for SBUV/2 data). This software creates a small header record at the beginning of the file which is known as the TBM header and is described in detail in Section 2.1.1. Level 1b tapes in SSB's archive do **not** contain a TBM record, although any Level 1b tape sent to a user by SSB will contain a TBM record.

Data sets may be stacked sequentially on tape. If a data set extends across two tapes (split data set), there will be an end of file (EOF) on the first tape and a double EOF after the last data set on the second tape. Note: there will **not** be any headers before the data on the second tape. User's software, when detecting end of medium while reading data records, should request the next tape and resume reading the records of the current data set. If a user cannot handle split data sets, the area of interest must be reduced through some selection process.

**Unless otherwise requested, all Level 1b tapes generated by SSB will be written with TBM Header, packed data, and no split data sets.** For example, if a user wants three full data set copies of LAC data on 3480 cartridges, the first two data sets will be placed on Tape 1 and the third will be placed on Tape 2 (rather than splitting the third data set across two tapes). See Table 2.3-2 for the volume of data available on IBM 3480 cartridges.

### 2.1.1 Record and File Structure

Each copy of a Level 1b data set will be written on tape as a separate file (a series of records followed by an EOF). Regardless of whether a full copy or area, time, or channel selection is made, the following format applies.

The record structure of each file (data set) **except LAC/HRPT** is as shown below:

Record 1: TBM (Terabit memory) Header record (122 bytes)
Record 2: Data Set Header record
Records 3-n: Data records

However, the above record structure does not hold true for any **LAC/HRPT** data sets. These particular data sets contain two data records for each scan. Each record has 7,400 bytes; therefore, the Data Set Header Record is also contained in two 7,400-byte records (the first record contains the Data Set Header and the second record is meaningless). The record structure of each file for LAC/HRPT data sets is as follows:

Record 1: TBM Header record (122 bytes)
Record 2: Data Set Header record (7,400 bytes)

Record 3: Dummy (7,400 bytes)
Records 4-n: Data records (7,400 bytes)

The above tape format also applies to data received from SSB prior to April 1985 when the TBM system was shut down. These data always included a TBM Header Record since they were accessed using the TBM. Currently, SSB's software creates a TBM Header record directly from operator input of the data set name and selection criteria. Users can verify which selection criteria were used by checking the TBM Header record.

The TBM Header contains information as to the type of data, selection parameters used, etc. The TBM Header record is 122 bytes in length and all fields are ASCII characters except the Channels Selected field which is in binary. The format for the TBM Header record is contained in Table 2.1.1-1.

**Table 2.1.1-1. TBM Header Record Format.**

| Byte # | # of Bytes in Field | Contents |
|---|---|---|
| 31-74 | 44 | Data Set Name |
| 75 | 1 | Total/Selective Copy (AT@ or AS@) |
| 76-78 | 3 | Beginning Latitude |
| 79-81 | 3 | Ending Latitude |
| 82-85 | 4 | Beginning Longitude |
| 86-89 | 4 | Ending Longitude |
| 90-91 | 2 | Start Hour |
| 92-93 | 2 | Start Minute |
| 94-96 | 3 | Number of Minutes |
| 97 | 1 | Appended Data Selection (AY@ or AN@) |
| 98-117 | 20 | Channels Selected (in binary) |
| 118-119 | 2 | Sensor Data Word Size (ASCII) |

The **data set name** is in the same format as described in Section 2.0.3. The **total/selective copy** field is one byte long and contains either a "T" or an "S" for total or selective copy, respectively.

The **beginning and ending latitude and longitude** fields give the range of latitude and longitude if either or both were selected. If the latitude or longitude select option is not used, these fields will have "ALL" coded in them to indicate all latitudes or longitudes.

The **start hour** and **minute** fields indicate the beginning time of the selected data set. The **number of minutes** field indicates the number of minutes contained in the selected data set. "AL" indicates there was no time selection, and all times were included.

The **appended data selection** field indicates whether or not Earth location was appended to the data. Appended data are always included with any Level 1b data obtained from SSB. This is indicated by a "Y" in the field for Yes.

The **channels selected** field contains 20 bytes corresponding to 20 possible channels. The value of each byte can be either 0 or 1. If the data have been selected by channel, then byte 75 will contain an "S" for Select and there will be a 1 in each appropriate channel position in the channels selected field. If the total dataset has been chosen, byte 75 will contain a "T" for Total and there will be a 0 in each channel position. The channel number is indicated by the position of the byte (e.g., Channel 4 would be found in byte 4 of the field). However, channel select HIRS data are not ordered chronologically from 1 to 20. They are in the order indicated in Section 4.1.2.1 (i.e., byte 2 would indicate Channel 17, etc.).

The **sensor data word size** field contains 2 bytes in ASCII which indicate the size of the sensor data words in the dataset. Valid values are 08, 10 or 16; which corresponds to 8 bit (unpacked), 10 bit (packed) and 16 bit (unpacked) formats, respectively.

Table 2.1.1-2 contains the character code conversion from hexadecimal to ASCII code. This may be useful when reading the TBM Header Record.

The format of the Data Set Header is described in Section 2.0.4. Note that the Data Set Header Record will always contain the same number of bytes as a full channel data record. For full data set copies, the format of each type of data record is described in Sections 3 and 4 for AVHRR and TOVS, respectively.

**Table 2.1.1-2. Character Code Conversion (ASCII).**

| HEX | ASCII | HEX | ASCII | HEX | ASCII |
|---|---|---|---|---|---|
| OD | CR | 41 | A | 4F | O |
| 20 | SP | 42 | B | 50 | P |
| 2B | + | 43 | C | 51 | Q |
| 2E | . | 44 | D | 52 | R |
| 30 | 0 | 45 | E | 53 | S |
| 31 | 1 | 46 | F | 54 | T |
| 32 | 2 | 47 | G | 55 | U |
| 33 | 3 | 48 | H | 56 | V |
| 34 | 4 | 49 | I | 57 | W |
| 35 | 5 | 4A | J | 58 | X |
| 36 | 6 | 4B | K | 59 | Y |
| 37 | 7 | 4C | L | 5A | Z |
| 38 | 8 | 4D | M | 5F | - |
| 39 | 9 | 4E | N | | |

## 2.2 Level 1b Data Record Formats

This section describes two general types of data formats which can be obtained from SSB. The first format is the most commonly used and is called the packed data format. The packed format is the format in which the data are archived by SSB. It takes up the least amount of tape but is more difficult to use because of its' compressed nature. This format is described in Section 2.2.1. The second format is known as the "16-bit unpacked format" and is described in Section 2.2.2. It consists of the video (channel) data being "unpacked" into two 16-bit words in four bytes (32 bits), right justified. When the data is selected by channel, the format will automatically be the "16-bit unpacked" format.

### 2.2.1 **Packed Data Format**

The packed data format is the standard format in which the data are received from NESDIS and in which they are ultimately archived by SSB. It is the default if the user does not request a specific format. Because of the sheer volume of satellite data, the packed data format is preferred for storing large quantities of data. However, due to the method of packing, it is more difficult to write software to handle this data. Basically, the packed data format contains the data arranged with as few spaces or gaps between the data elements as possible. This means that it is usually not possible to directly read the data on word or halfword boundaries.

In the case of the AVHRR data, the video (channel) data are packed as three 10-bit samples in four bytes, right-justified. The first two bits of each four-byte group are zero. The channels are interleaved, so the samples have the following order: scan point 1 (Channels 1, 2, 3, 4, 5), scan point 2 (Channels 1, 2, 3, 4, 5), etc. The detailed packed data format can be found in Section 3.1.2.1 for GAC data and in Section 3.2.2.1 for LAC/HRPT data. Appendix B should be helpful in unpacking this data format. Figure 2.2.1-1 illustrates the packed data format for AVHRR data. Since the TOVS data are generated by three distinct instruments, their packed data format is

```
Bytes   |<--------4----->|<------3------->|<-----2-------->|<-----1------->|

Bits    .3.3.2.2.2.2.2.2.2.2.2.2.1.1.1.1.1.1.1.1.1.1.9.8.7.6.5.4.3.2.1.0.
        .1.0.9.8.7.6.5.4.3.2.1.0.9.8.7.6.5.4.3.2.1.0. . . . . . . . . . .

                 Scan Point 1        Scan Point 1         Scan Point 1
        |0 0|<----Channel 1--->|<---Channel 2--->|<---Channel 3--->|
                   (10 bits)           (10 bits)            (10 bits)
```

**Figure 2.2.1-1 Packed Data Format for AVHRR Data**

more complex and will not be discussed here. For detailed information on the TOVS packed data format, refer to Sections 4.1.2.1, 4.2.2.1, and 4.3.2.1 for the HIRS/2, SSU, and MSU data, respectively.

### 2.2.2 **16-bit Unpacked Data Format**

The 16-bit unpacked data format is an ideal format for the occasional satellite data user with a small area and period of interest. The video data are unpacked into two 16-bit words (INTEGER*2 words) in four bytes using SSB's software. The channel data are contained in the ten least significant bits and the six most significant bits are zero-filled. This unpacked data format requires more storage on magnetic tape but considerably less investment in software development. The specific formats for the 16-bit unpacked data format vary according to data type and are fully described in the "Full Data Set Copy" subsection for each data type in Sections 3 and 4. Figure 2.2.2-1 illustrates the 16-bit unpacked data format for AVHRR data.

```
Bytes   |<----4--------->|<-------3------>|<-------2------>|<-------1----->|

Bits    .3.3.2.2.2.2.2.2.2.2.2.2.1.1.1.1.1.1.1.1.1.1.9.8.7.6.5.4.3.2.1.0.
             .1.0.9.8.7.6.5.4.3.2.1.0.9.8.7.6.5.4.3.2.1.0.

                     Scan point 1                Scan point 1
        |0 0 0 0 0 0|<---Channel 1---->|0 0 0 0 0 0|<---Channel 2--->|
                       (10 bits)                       (10 bits)
```

**Figure 2.2.2-1 Unpacked Data Format for AVHRR Data**

## 2.3 Data Volume per Tape

This section contains information concerning the size of data records for each instrument, the amount of data (in minutes) which will fit on an IBM 3480 cartridge, and the normal lengths (in minutes) of each type of data set. The approximate amount of data requested can also be computed by determining the number of minutes over a specific area using the spinner described in Section 1.2.

Table 2.3-1 shows the record length (in bytes) for each type of instrument, depending on whether the data desired is full copy or channel select. It also shows the number of records per scan and number of scans per minute for each instrument. Note that the record length of packed TOVS data is actually larger than the unpacked TOVS because the channel selection software eliminates portions of the original TOVS data that were deemed unnecessary when the software was written in 1978. SSB does **not recommend** channel selection for TOVS Level 1b data.

Table 2.3-2 contains the number of minutes of each type of Level 1b data (with the exception of SBUV/2 data) for full copy or channel select in the packed and unpacked data format which can be written onto an IBM 3480 cartridge.

Typical lengths of data sets in minutes are approximately 110 minutes for GAC and all TOVS data sets, 11 to 13 minutes for HRPT, and 10 minutes for LAC.

| Table 2.3-1. Level 1b Data Record Length (Bytes). | | | | | | |
|---|---|---|---|---|---|---|
| **Data Type** | **1 Channel** | **2 Channels** | **3 Channels** | **Full Copy Packed** | **Full Copy Unpacked** | **Comments** |
| GAC | 2,536 | 4,168 | 5,808 | 6,440 | 9,080 | 2 scans/record, 120 scans/minute |
| LAC/ HRPT | 2,272 | 4,320 | 6,368 | 7,400 | 10,464 | 2 records/scan, 360 scans/minute |
| HIRS/2 | 1,492 | 1,604 | 1,716 | 4,253 | 3,620 | 1 record/scan, 9.4 scans/minute |
| MSU | 204 | 228 | 256 | 437 | 280 | 1 record/scan, 2.3 scans/minute |
| SSU | 308 | 436 | 564 | 2,498 | 564 | 1 record/scan, 1.9 scans/minute |

| Table 2.3-2. Level 1b IBM 3480 Cartridge Volume (Minutes/Cartridge). | | | | | |
|---|---|---|---|---|---|
| **Data Type** | **1 Channel** | **2 Channels** | **3 Channels** | **Full Copy Packed** | **Full Copy Unpacked** |
| GAC | 625 | 455 | 358 | 330 | 251 |
| LAC/HRPT | 55 | 37 | 28 | 24 | 18 |
| HIRS/2 | 5,214 | 5,045 | 4,888 | 2,864 | 3,194 |
| MSU | 34,537 | 34,114 | 33,960 | 31,029 | 33,292 |
| SSU | 40,000 | 37,931 | 35,610 | 20,000 | 35,610 |