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## Contents

1 **Introduction**  

2 **BUFR format**  
   2.1 Indicator section  
   2.2 Identification section  
   2.3 Optional section  
   2.4 Data description section  
   2.5 Data section  
   2.6 End section  

3 **BUFR software**  
   3.1 Bufr binary tables  
   3.2 Defaults  
   3.3 Decoding and encoding  
      3.3.1 Subroutine BUFREX  
      3.3.2 Subroutine BUFREN  
   3.4 Error codes  
   3.5 Partial expansion  
      3.5.1 Subroutine BUSRQ  
      3.5.2 Example  
   3.6 Printing routines  
      3.6.1 To print Section 0  
      3.6.2 To print Section 1  
      3.6.3 To print Section 2  
      3.6.4 To print Section 3  
      3.6.5 To print data  
   3.7 Bufr software tools  
      3.7.1 Subroutine BUS012  
      3.7.2 Subroutine BUSEL  
      3.7.3 Subroutine BUUKEY  
      3.7.4 Subroutine BUPKEY
4 Quality control in BUFR

4.1 Quality control example .............................................. 48
4.2 Examples ..................................................................... 53
   4.2.1 To unpack and print data ......................................... 53
   4.2.2 To expand data descriptors only ................................. 60
1 Introduction

FM-94 BUFR (Binary Universal Form for data Representation) has been designed to achieve efficient exchange and storage of meteorological and oceanographic data. It is self defining, table driven and very flexible data representation system, especially for huge volumes of data.

The User’s Guide is described in three sections.

Section 1 describes Bufr format in general, and it is useful for those who are not familiar with the Bufr concept.

Section 2 explains Bufr software usage. It contains FORTRAN subroutines for expanding and packing Bufr data. A number of routines described shall be used as tools.

A quality control representation in the Bufr is given in section 3.
2 BUFR format

A full definition of the BUFR form is given in WMO Manual on Codes, Volume I, International Codes, Part B-Binary Codes, WMO-No.306, FM 94-IX Ext. BUFR. This section offers a brief description of the basic structure and representation of the BUFR code.

The BUFR form is a binary representation of meteorological data. It is a continuous bit stream made up of a sequence of octets (one octet is eight bits). The only part of BUFR where information does not end on byte boundaries is the data section, where a length of BUFR table B elements can have any number of bits (although it must not exceed the number of bits in a computer word for non-character data).

A BUFR message consists of six sections, some of which may be completely optional (section 2) or partially optional (section 1).

The representation of data in the form of a series of bits is independent of any particular machine representation. It is important to stress that the BUFR representation is not suitable for data visualisation without computer interpretation.

The data section consists of one or more data subsets of related meteorological data which are defined, described and represented by a single Bufr table D entry. For observational data, one subset corresponds to one observation. The data section can be in compressed or uncompressed form.

Each section included in the message always contain an even number of octets. If necessary, sections must be appended with bits set to zero to fulfil this requirement.

A BUFR message is comprised of the following sections:

- Indicator section
- Identification section
- Optional section
- Data description section
- Data section
- End section

2.1 Indicator section

Indicator section or Section 0 of a Bufr message has a fixed length of eight octets. Information about the total size of the BUFR message in octets 5-7 is very useful for reading BUFR data from pure binary files. The content of Section 0 is given in the Table 1.

2.2 Identification section

This section contains information relevant to data recognition without performing complete expansion of data. Data type and observation date and time are the most important parts of it. In the case of multi-subset data the time of the earliest observation should be packed into section 1. This section also contains all information necessary to define the Bufr tables used.
### 2.3 Optional section

The presence of Section 2 of the Bufr message is indicated by a flag in the 8th byte of Section 1. This section can be used locally by Automated Data Processing centres. This Section is used to keep the Report Data Base key.

The layout of Section 2 is given in table 3.

---

**Table 1: Bufr Section - 0**

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>BUFR four letters in CCITT International Alphabet No.5</td>
</tr>
<tr>
<td>5-7</td>
<td>Total length of Bufr message in bytes</td>
</tr>
<tr>
<td>8</td>
<td>Bufr Edition number</td>
</tr>
</tbody>
</table>

The layout of the Identification section is given in Table 2.

**Table 2: Bufr Section - 1**

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Length of section 1</td>
</tr>
<tr>
<td>4</td>
<td>Bufrmaster table (zero id standard WMO FM 94-IX BUFR tables are used)</td>
</tr>
<tr>
<td>5</td>
<td>Originating/generating sub-centre</td>
</tr>
<tr>
<td>6</td>
<td>Originating/generating centre: Code table 001031</td>
</tr>
<tr>
<td>7</td>
<td>Update sequence number (zero for original BUFR messages; incremented by one for updates)</td>
</tr>
<tr>
<td>8</td>
<td>Bit 1 = 0 No optional section</td>
</tr>
<tr>
<td></td>
<td>Bit 1 = 1 Optional section follows</td>
</tr>
<tr>
<td></td>
<td>Bit 2-8 Set to zero (reserved)</td>
</tr>
<tr>
<td>9</td>
<td>Originating/generating centre: Code table 001031</td>
</tr>
<tr>
<td>10</td>
<td>Bufr message subtype (defined by local automatic data processing centre)</td>
</tr>
<tr>
<td>11</td>
<td>Version number of master table used (currently 11 for WMO FM 94-IX Ext. BUFR tables)</td>
</tr>
<tr>
<td>12</td>
<td>Version number of local tables used to augment the master table in use</td>
</tr>
<tr>
<td>13</td>
<td>Year of century (100 for 2000 year)</td>
</tr>
<tr>
<td>14</td>
<td>Month</td>
</tr>
<tr>
<td>15</td>
<td>Day</td>
</tr>
<tr>
<td>16</td>
<td>Hour</td>
</tr>
<tr>
<td>17</td>
<td>Minute</td>
</tr>
<tr>
<td>18-</td>
<td>Reserved for local use by ADP centres</td>
</tr>
</tbody>
</table>
## 2.4 Data description section

This section describes the data in the data section. The information which can be found in the first seven octets is the number of subsets in the message, their form and the type of data (observation/non-observation). The data descriptors start in the 8th octet of the section 3. Each descriptor is spread over two bytes and contains three parts. If \( F = 0 \), the descriptor is an element descriptor and values of \( X \) and \( Y \) define entries in Bufr Table 4. For \( F = 1 \), the descriptor is a replication descriptor. If \( F = 2 \), the descriptor is one of the operators from bufr Table C. \( F = 3 \) means that the descriptor represents the sequence descriptor from Bufr Table D. The table D entries contain a list of element descriptors, operators, and/or other sequence descriptors.

In an ideal situation, data in Section 4 should be described by one Bufr Table D entry only.

\( X \) stands for class of elements in the range from 0-63 and \( Y \) is an entry within class 0-255. Classes 48-63 are reserved for local use and entries from 192-255 within all classes are also reserved for local usage.

Layout of Data description section is given in the Table 5.

---

### Table 3: Bufr Section - 2

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Length of section in bytes</td>
</tr>
<tr>
<td>4</td>
<td>Set to zero (reserved)</td>
</tr>
<tr>
<td>5-</td>
<td>reserved for local use by ADP centres</td>
</tr>
</tbody>
</table>

### Table 4: Descriptor reference

<table>
<thead>
<tr>
<th>( F )</th>
<th>( X )</th>
<th>( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 bits</td>
<td>6 bits</td>
<td>8 bits</td>
</tr>
</tbody>
</table>

---

### Table 5: Data description section

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Length of section</td>
</tr>
<tr>
<td>4</td>
<td>set to zero (reserved)</td>
</tr>
<tr>
<td>5-6</td>
<td>Number of data subsets</td>
</tr>
<tr>
<td>7</td>
<td>Bit 1 = 1 Observed data&lt;br&gt;Bit 1 = 0 Other data&lt;br&gt;Bit 2 = 1 Compressed data&lt;br&gt;Bit 2 = 0 Non compressed data&lt;br&gt;Bits 3-8 set to zero ( reserved)</td>
</tr>
<tr>
<td>8-</td>
<td>A collection of element descriptors, replication descriptors, operator descrip-&lt;br&gt;tor and sequence descriptors, which define the form and contents of individual data elements comprising one data subset in the data section.</td>
</tr>
</tbody>
</table>
2.5 Data section

The Data section, like all sections, starts with the length of Section 4 followed by a continuous stream of bits from byte 5 onward.

Layout of Data section is given in the Table 6.

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Length of section in bytes</td>
</tr>
<tr>
<td>4</td>
<td>set to zero (reserved)</td>
</tr>
<tr>
<td>5-</td>
<td>Binary data as defined by sequence descriptors</td>
</tr>
</tbody>
</table>

2.6 End section

The End section is comprised of four “7” characters in CCITT International Alphabet No.5 and this marks the end of the Bufr message. The layout of the End section is given in the Table 7.

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>“7777” (coded according to the CCITTIA No 5)</td>
</tr>
</tbody>
</table>
3 BUFR software

The first version of ECMWF Bufr software was designed and implemented in 1987. A great deal of experience has been gathered in handling binary coded observations since. Bufr software is written in FORTRAN 77.

Versions for C90, VAX, IBM, SGI, SUN, HP and for all UNIX and LINUX based platforms are available. It has been installed on Mac OSX as well. The only hardware dependent routines are for bit manipulation, where PGBYTES.c (a C routine) is used on all platforms.

3.1 Bufr binary tables

BUFR is a table driven system. It uses three main tables.

- Bufr Table B - classification elements
- Bufr Table C - text and meaning of all code/flag tables
- Bufr Table D - list of common sequences

Bufr Tables B, C and D are used to collect all necessary information to pack/unpack Bufr data. The software uses corresponding binary versions of the Bufr Tables, which have to be created from the corresponding text versions. Which table is to be loaded is decided at runtime using information from Section 1 of the Bufr message. The naming convention for Bufr binary tables is as follows:

Bwwwxxxyyzz Cwwwxxxyyzz Dwwwxxxyyzz where

- www - Originating sub-centre
- xxx - Originating centre
- yy - Version number of master table used
- zz - Version number of local table used

ECMWF is currently using B0000981101, C0000981101 and D0000981101 tables. Keep in mind that Bufr Table C in this software is a code table. Bufr has Table C in its definition, where Bufr Operators are defined.

To create binary Bufr tables, make an executable from FORTRAN program tables.f. Run the program and answer the prompts. The output will be as follows:

```
ORIGINATING SUB-CENTER :0
ORIGINATING CENTER :98
CREATE BUFR TABLE B (Y/N) :y
VERSION NUMBER OF MASTER TABLE :11
VERSION NUMBER OF LOCAL TABLE :1

Input Table : B0000981101.TXT
Binary Table : B0000981101
```
CREATE BUFR TABLE C (Y/N) : n
CREATE BUFR TABLE D (Y/N) : y
VERSION NUMBER OF MASTER TABLE : 11
VERSION NUMBER OF LOCAL TABLE : 1

Input Table : D0000981101.TXT
Binary Table : D0000981101

Total number of entries in the Table B is 1268
Total number of entries in the Table D is 338

3.2 Defaults

Integer missing value indicator:

$$NVIND = 2147483647$$

Real missing value indicator:

$$RVIND = 1.7E38$$

Default path for Bufr Tables is hard coded in the software. To change the path set environmental variable BUFR_TABLES :

```bash
export BUFR_TABLES=/.../
```

The path must end with "/"
3.3 Decoding and encoding

3.3.1 Subroutine BUFREX

Purpose

Decodes Bufr message into fully expanded form, returning information relevant to all Bufr Sections, expanded values, Bufr Table B element names and units.

Interface

CALL BUFREX(KBUFL, KBUFF, KSUP, KSEC0, KSEC1, KSEC2, KSEC3, KSEC4, KELEM, CNAMES, CUNITS, KVALS, VALUES, CVALS, KERR)

where:

- Integer variables are denoted by first letter K.
- Real variables are denoted by first letter V.
- Character variables are denoted by first letter C.

Input arguments

- KBUFL - An INTEGER variable containing length of Bufr message in words.
- KBUFF - An INTEGER array containing Bufr message.
- KELEM - An INTEGER variable containing expected number of expanded elements
- KVALS - An INTEGER variable containing expected number of data values

Output arguments

- KSEC0 - An INTEGER array (size 3) containing Bufr Section 0 information.
- KSEC1 - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly.
- KSEC2 - An INTEGER array of 64 words containing Bufr Section 2 information. ECMWF uses this section to store Report Data Base key.
- KSEC3 - An INTEGER array of 4 words containing Bufr Section 3 information.
- KSEC4 - An INTEGER array of 2 words containing Section 4 information.
- KSUP - An INTEGER array (size 9) containing supplementary information.
3.3 Decoding and encoding

- **CNAMES** - CHARACTER*64 array of KELEM words containing element names.
- **CUNITS** - CHARACTER*24 array of KELEM words containing element units.
- **VALUES** - REAL*8 array of KVALS words containing element values.
- **CVALS** - CHARACTER*80 array of KVALS containing CCITT IA No.5 element entries.
- **KERR** - An INTEGER containing an error code.

**KSEC0** - An INTEGER array (size 3) containing Bufr Section 0 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 0 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Total length of Bufr message in bytes</td>
</tr>
<tr>
<td>3</td>
<td>Bufr Edition number</td>
</tr>
</tbody>
</table>

**KSEC1** - An INTEGER array of at least 40 words containing Bufr Section 1 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 1 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Bufr Edition number</td>
</tr>
<tr>
<td>3</td>
<td>Originating centre</td>
</tr>
<tr>
<td>4</td>
<td>Update sequence number</td>
</tr>
<tr>
<td>5</td>
<td>Flag (presence of Section 2 in the message)</td>
</tr>
<tr>
<td>6</td>
<td>Bufr message type (Bufr Table A)</td>
</tr>
<tr>
<td>7</td>
<td>Bufr message subtype (local use)</td>
</tr>
<tr>
<td>8</td>
<td>Version number of local table used</td>
</tr>
<tr>
<td>9</td>
<td>Century year</td>
</tr>
<tr>
<td>10</td>
<td>Month</td>
</tr>
<tr>
<td>11</td>
<td>Day</td>
</tr>
<tr>
<td>12</td>
<td>Hour</td>
</tr>
<tr>
<td>13</td>
<td>Minute</td>
</tr>
<tr>
<td>14</td>
<td>Bufr Master Table used</td>
</tr>
<tr>
<td>15</td>
<td>Version number of Master table used</td>
</tr>
<tr>
<td>16</td>
<td>Originating sub-centre</td>
</tr>
<tr>
<td>18-</td>
<td>Local ADP centre information (byte by byte)</td>
</tr>
</tbody>
</table>

**KSEC2** - An INTEGER array of 64 words containing Bufr Section 2 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2-</td>
<td>Report Data Base key in packed form</td>
</tr>
</tbody>
</table>
**KSEC3** - An INTEGER array of 4 words containing Bufr Section 3 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 3 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Reserved</td>
</tr>
<tr>
<td>3</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>4</td>
<td>Flag (data type, compression)</td>
</tr>
</tbody>
</table>

**KSEC4** - An INTEGER array of 2 words containing Section 4 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 4 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

**KSUP** - An INTEGER array (size 9) containing supplementary information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dimension of KSEC1 array</td>
</tr>
<tr>
<td>2</td>
<td>Dimension of KSEC2 array</td>
</tr>
<tr>
<td>3</td>
<td>Dimension of KSEC3 array</td>
</tr>
<tr>
<td>4</td>
<td>Dimension of KSEC4 array</td>
</tr>
<tr>
<td>5</td>
<td>Real number of expanded elements</td>
</tr>
<tr>
<td>6</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>7</td>
<td>Real number of elements in CVALS array</td>
</tr>
<tr>
<td>8</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>9</td>
<td>Dimension of KSEC0 array</td>
</tr>
</tbody>
</table>

**Method**

A Bufr message passed as an argument to this routine is decoded section by section. Before Section 3 expansion Bufr tables are loaded using KSEC1 information to create table names. The loaded Bufr tables are kept in memory and swapped only if the next message is requesting different tables.

Section 3 Data descriptors are unpacked and expanded applying all necessary operators in force and creating a list of Bufr Table B elements which correspond one to one to the data in the Data section of the Bufr message. Word and bit pointers are calculated for each element in the message.

Having all this information, unpacking of the data is performed applying reference value and scaling to get the final value for one element in the Bufr message. Unpacked data are stored in VALUES array. The corresponding element names and units are stored in the CVALUES and CUNITS arrays respectively.

To achieve efficiency, original Data descriptors are saved for the following comparison. If the Data descriptors for the next observation are not different from the previous, the former word and bit pointers to the elements are used saving time for data descriptors expansion.
If a Bufr Table B element is type character, the corresponding VALUES element contains a real number which, when truncated to an integer represents

\[ \text{index} \times 1000 + \text{length} \]

where:

- index - subscript of the element in CVALS where character string is stored.
- length - number of characters represented.

In the case of multi subset data, the one dimensional array VALUES contains all subsets of data. The formula to find the index to the VALUES array of the i-th element of observation is:

\[ \text{index}=i + (\text{nsub}-1)\times\text{KELEM} \]

so start of next subset is KELEM apart.

Current version of the Bufr software can handle KELEM up to 80000 and KVALS up to 360000.

**Externals**

- BUEXS0 - Expands Section 0 of Bufr message
- BUEXS1 - Expands Section 1 of Bufr message
- BUEXS2 - Expands Section 2 of Bufr message
- BUEXS3 - Expands Section 3 of Bufr message
- BUGBTS - Loads Bufr tables
- BUEXS4 - Expands Section 4 of Bufr message
- BUEXS5 - Expands Section 5 of Bufr message

**Reference**

### 3.3.2 Subroutine BUFREN

#### Purpose

Creates a packed Bufr message from the information contained in the arguments of the subroutine.

#### Interface

```fortran
CALL BUFREN(KSEC0, KSEC1, KSEC2, KSEC3, KSEC4,
             KTDLEN, KTDLST, KDLEN, KDATA, KELEM, KVALS,
             VALUES, CVALS, KBUFL, KBUFF, KERR)
```

where

- Integer variables are denoted by first letter K.
- Real variables are denoted by first letter V.
- Character variables are denoted by first letter C

#### Input arguments

- **KSEC0** - An INTEGER array (size 3) containing Bufr Section 0 information
- **KSEC1** - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly.
- **KSEC2** - An INTEGER array of 64 words containing Bufr Section 2 information. ECMWF uses this section to store Report Data Base key.
- **KSEC3** - An INTEGER array of 4 words containing Bufr Section 3
- **KSEC4** - An INTEGER array of 2 words containing Section 4 information.
- **KTDLEN** - An INTEGER variable containing the number of data descriptors to be packed in Section 3 of Bufr message
- **KTDLST** - An INTEGER array containing the list of KTDLEN data descriptors
- **KDLEN** - An INTEGER variable containing the dimension of KDATA array
- **KDATA** - An INTEGER array containing the delayed replication factors which which appear in the Data section of Bufr message
- **KELEM** - An INTEGER variable containing the expected number of expanded elements
- **KVALS** - An INTEGER variable containing the expected number of data values
- **VALUES** - REAL*8 array of KVALS words containing element values.
- **CVALS** - CHARACTER*80 array of KVALS containing CCITT IA No.5 element entries.
### KSEC0
An INTEGER array (size 3) containing Bufr Section 0 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 0 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Total length of Bufr message in bytes</td>
</tr>
<tr>
<td>3</td>
<td>Bufr Edition number</td>
</tr>
</tbody>
</table>

### KSEC1
An INTEGER array of at least 40 words containing Bufr Section 1

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 1 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Bufr Edition number</td>
</tr>
<tr>
<td>3</td>
<td>Originating centre</td>
</tr>
<tr>
<td>4</td>
<td>Update sequence number</td>
</tr>
<tr>
<td>5</td>
<td>Flag (presence of Section 2 in the message)</td>
</tr>
<tr>
<td>6</td>
<td>Bufr message type (Bufr Table A)</td>
</tr>
<tr>
<td>7</td>
<td>Bufr message subtype (local use)</td>
</tr>
<tr>
<td>8</td>
<td>Version number of local table used</td>
</tr>
<tr>
<td>9</td>
<td>Century year</td>
</tr>
<tr>
<td>10</td>
<td>Month</td>
</tr>
<tr>
<td>11</td>
<td>Day</td>
</tr>
<tr>
<td>12</td>
<td>Hour</td>
</tr>
<tr>
<td>13</td>
<td>Minute</td>
</tr>
<tr>
<td>14</td>
<td>Bufr Master Table used</td>
</tr>
<tr>
<td>15</td>
<td>Version number of Master table used</td>
</tr>
<tr>
<td>16</td>
<td>Originating sub-centre</td>
</tr>
<tr>
<td>18-</td>
<td>Local ADP centre information (byte by byte)</td>
</tr>
</tbody>
</table>

### KSEC2
An INTEGER array of 64 words containing Bufr Section 2

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2-</td>
<td>Report Data Base key in packed form</td>
</tr>
</tbody>
</table>

### KSEC3
An INTEGER array of 4 words containing Bufr Section 3

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 3 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Reserved</td>
</tr>
<tr>
<td>3</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>4</td>
<td>Flag (data type, compression)</td>
</tr>
</tbody>
</table>
KSEC4  An INTEGER array of 2 words containing Section 4 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 4 in bytes</td>
</tr>
<tr>
<td>2-</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Output arguments

- KBUFL - An INTEGER variable containing the length of the Bufr message in words.
- KBUFF - An INTEGER array containing the Bufr message.
- KERR - An INTEGER containing an error code.

Method

A basic approach when this software was designed to have a one to one correspondence between expanded data descriptors and the data itself.

The input arguments have to be filled in before packing. The lengths of the Sections and the total Bufr message length are set by the software. The lengths of the Section 1 and 2 must be supplied by the user. The other Section lengths ought to be set to zero. The default size of the Section 1 is 18 octets if there are no local entries. The Section 2 is optional section, and ECMWF uses it to store Report Data Base key. In this case the length of the Section 2 is 52 octets.

Before setting values in the VALUES array, it is recommended to initialise it with the MISSING value indicator.

The Optional Section 2 and a local part of Section 1 must be in the packed form because encoder packs these information in byte by byte manner.

The Data descriptors stored in the KTDLST array are expanded taking delayed replication factor values from KDATA array if needed. The order of replication factor values must be as they appear in the data.

The VALUES array must be filled in correspondence with previously described data elements. In the case of multi subsets, the pointer of the ith element in VALUES array is:

\[ \text{index}=i+(\text{nsub}-1)*\text{KELEM} \]

which implies that the first element of the second subset begins at KELEM+1 position even if the number of elements in the observation is less than KELEM.

For character information or elements having CCITT IA No.5 as units, VALUES array element contains a real number which, when truncated to an integer represents

\[ \text{value}=\text{isub}*1000+\text{length} \]
3.3 Decoding and encoding

where isub is a subscript of the element in CVALS array, where the character string is stored and the length represents number of bytes/character occupied by this element.

To find out what one observation should look like, the BUXDES routine can be used. This routine expands data descriptors for the user. The procedure to print an expanded list of the data descriptors is the same as to print Section 3 of Bufr message.

**Externals**

- BUENS0 - Packs Section 0 of Bufr message
- BUENS1 - Packs Section 1 of Bufr message
- BUENS2 - Packs Section 2 of Bufr message
- BUENS3 - Packs Section 3 of Bufr message
- BUETAB - Loads required Bufr tables
- BUENS4 - Packs Section 4 of Bufr message
- BUENS5 - Packs Section 5 of Bufr message

**Reference**

3.4 Error codes

The errors returned by the Bufr decoding/encoding routines can be zero, negative and positive. The zero returned error code means no errors detected, negative error is a warning error which can occur during packing. If the value to be packed is too big, BUFREN will pack the truncated value and return a negative error code. The hard errors are positive.

The Error codes are given in Table 8.

Table 8: Return error codes

<table>
<thead>
<tr>
<th>Error number</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start of BUFR message not found</td>
</tr>
<tr>
<td>2</td>
<td>End of BUFR message not found</td>
</tr>
<tr>
<td>3</td>
<td>Array to receive BUFR message too small</td>
</tr>
<tr>
<td>4</td>
<td>JSEC1 parameter too small. Local ADP centre information skipped</td>
</tr>
<tr>
<td>5</td>
<td>JSEC2 parameter too small. Local ADP centre information skipped</td>
</tr>
<tr>
<td>6</td>
<td>Error during read BUFR table B</td>
</tr>
<tr>
<td>7</td>
<td>Error during read BUFR table C</td>
</tr>
<tr>
<td>8</td>
<td>Error during read BUFR table D</td>
</tr>
<tr>
<td>9</td>
<td>Open error</td>
</tr>
<tr>
<td>10</td>
<td>Error during closing BUFR table B</td>
</tr>
<tr>
<td>11</td>
<td>Error during close BUFR table C</td>
</tr>
<tr>
<td>12</td>
<td>Error during close BUFR table D</td>
</tr>
<tr>
<td>13</td>
<td>Number of bits to be extracted greater than number of bits per computer word</td>
</tr>
<tr>
<td>14</td>
<td>Argument KVALS too small</td>
</tr>
<tr>
<td>15</td>
<td>Increment value for compressed data too big</td>
</tr>
<tr>
<td>16</td>
<td>JSUBS parameter too small</td>
</tr>
<tr>
<td>17</td>
<td>JWORK parameter too small</td>
</tr>
<tr>
<td>18</td>
<td>Replication factor equal to zero</td>
</tr>
<tr>
<td>19</td>
<td>Delayed replication factor too big.</td>
</tr>
<tr>
<td>20</td>
<td>Table D reference not found</td>
</tr>
<tr>
<td>21</td>
<td>Data descriptors operator not found</td>
</tr>
<tr>
<td>22</td>
<td>BUFR Operator name not found</td>
</tr>
<tr>
<td>23</td>
<td>Table B reference not found</td>
</tr>
<tr>
<td>24</td>
<td>Augmented table B reference not found</td>
</tr>
<tr>
<td>25</td>
<td>KELEM argument too small</td>
</tr>
<tr>
<td>26</td>
<td>Word pointer out of range</td>
</tr>
<tr>
<td>27</td>
<td>Too many subsets to be packed</td>
</tr>
<tr>
<td>28</td>
<td>Number to be packed too big</td>
</tr>
</tbody>
</table>

continued on next page
### Error codes

<table>
<thead>
<tr>
<th>Error number</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Number of descriptors KTDLEN too big</td>
</tr>
<tr>
<td>30</td>
<td>Number of elements greater than JELEM</td>
</tr>
<tr>
<td>31</td>
<td>Too few elements in KDATA array</td>
</tr>
<tr>
<td>32</td>
<td>Number of subsets equal to zero</td>
</tr>
<tr>
<td>33</td>
<td>Negative value to be packed</td>
</tr>
<tr>
<td>34</td>
<td>Number of bits to be packed greater than number of bits per computer word</td>
</tr>
<tr>
<td>35</td>
<td>Not used</td>
</tr>
<tr>
<td>36</td>
<td>Bad order of data descriptors</td>
</tr>
<tr>
<td>37</td>
<td>Wrong data descriptors</td>
</tr>
<tr>
<td>38</td>
<td>Partial expansion on total message not supported</td>
</tr>
<tr>
<td>39</td>
<td>Can not recognise feedback data in this message</td>
</tr>
<tr>
<td>40</td>
<td>Request flag illegal</td>
</tr>
<tr>
<td>41</td>
<td>Bit map not set</td>
</tr>
<tr>
<td>42</td>
<td>This element must be data present indicator</td>
</tr>
<tr>
<td>43</td>
<td>Table B element must follow bit map</td>
</tr>
<tr>
<td>44</td>
<td>Requested subset does not exist</td>
</tr>
<tr>
<td>45</td>
<td>There is no one requested element in the data</td>
</tr>
<tr>
<td>46</td>
<td>Input array is too small to receive information</td>
</tr>
</tbody>
</table>
3.5 Partial expansion

It is possible to expand only the requested subset of elements without unpacking the whole Bufr message. This method is called partial expansion.
To do partial expansion, the request has to be set by calling the BUSRQ routine before calling BUFREX.

3.5.1 Subroutine BUSRQ

Purpose

Sets flags and Bufr table B reference numbers of the requested elements for partial expansion.

Interface

CALL BUSRQ(KREQ,KRQL,KRQ,RQV,KERR)

where:

- Integer variable are denoted by first letter K.
- Real variables are denoted by first letter R.

Input arguments

- KREQ - An INTEGER array of 2 containing flags.

  KREQ(1)  -  0 All elements
  1 All original observation without quality control
  2 All original elements with quality control
  3 Only feedback information

  KREQ(2)  -  Flag of 6 bits

  Bit number    Meaning
  1 0 not used
  2 0 - No partial expansion
      1 - Partial expansion
  3 0 - No quality control
      1 - quality control
  4 0 - No statistics
      1 - Statistics
  5 0 - No difference statistics
      1 - Difference statistics
3.5 Partial expansion

6 0 - No substituted values
1 - Substituted values

- KRQL - An INTEGER containing the number of requested elements
- KRQ - An INTEGER array containing the list of requested elements (Bufr table B reference numbers)
- RQV - A REAL*8 array of KRQL containing a list of values signifying requested elements

Output arguments

- KERR - Error code

Method

The lists of flags and Bufr Table B reference numbers are used to designate requested Bufr elements. The elements from class 7 and 8 are possible qualifiers for the other elements if supplied with corresponding values.

The partial expansion is not supported for the whole analysis feedback Bufr messages (includes original observation and analysis variables followed by the statistics e.t.c.)

The list of the requested elements and corresponding word and bit pointers are created before expansion. These pointers are used to extract data from the Data section of the Bufr message.

The KRQ and RQV arrays have to be initialised by missing value indicators NVIND and RVIND respectively.

The KREQ(1) is useful to split the feedback Bufr message into original, quality control and analysis feedback data.

Externals

```
BUNPCK - Unpacks bit pattern
BUNPKS - Unpacks bit pattern in repeated way.
```

Reference

None
3.5.2 Example

Running BUFR program and answering prompts as below, 500 mb level information is unpacked by the BUFREX routine.

DO YOU WANT TO PRINT( Y/N ) : y
CODE TABLES TO BE PRINTED ( Y/N ) : n
DO YOU WANT ENCODING( Y/N ) : n
RECORD NUMBER TO START FROM : 1
REQUESTED ELEMENT : 007004
REQUESTED VALUE : 50000.
REQUESTED ELEMENT : 008001
REQUESTED VALUE :
REQUESTED ELEMENT : 010003
REQUESTED VALUE :
REQUESTED ELEMENT : 012001
REQUESTED VALUE :
REQUESTED ELEMENT : 012003
REQUESTED VALUE :
REQUESTED ELEMENT : 011001
REQUESTED VALUE :
REQUESTED ELEMENT : 011002
REQUESTED VALUE :
REQUESTED ELEMENT :
REQUESTED VALUE :
REQUESTED FLAG 1 : 1
REQUESTED FLAG 2 : 2

DO YOU WANT TO PRINT SECTION 0-3( Y/N ) : y

This is the output from the program:

ECMWF BUFR DECODING SOFTWARE VERSION - 2.0

Your path for Bufr tables is:
/home/ecmwf/emos_sms/tables/BUFR/test/

BUFR Tables to be loaded B000980201,C000980201,D000980201

BUFR SECTION 0
Length of section 0 (bytes) 8
Total length of Bufr message (bytes) 860
Bufr Edition number 2

BUFR SECTION 1
Length of section 1 (bytes) 18
Bufr Edition number 2
Originating centre 98
Update sequence number 1
Flag (presence of section 2) 128
Bufr message type 2
Bufr message subtype 101
Version number of local table 1
Year 94
Month 2
Day 16
3.5 Partial expansion

Hour 10
Minute 0
Version number of Master table 2
Bufr Master table 0

BUFR SECTION 2

Length of section 2 52

Report Data Base Key

RDB data type 5
RDB data subtype 101
Year 1994
Month 2
Day 16
Hour 10
Minute 0
Second 0
Latitude 1 1.37
Longitude 1 103.98
Identifier 48698
Total Bufr message length 860
Day (RDB insertion) 16
Hour (RDB insertion) 12
Minute (RDB insertion) 22
Second (RDB insertion) 18
Day (MDB arrival) 16
Hour (MDB arrival) 12
Minute (MDB arrival) 22
Second (MDB arrival) 7
Correction number 0
Part of message 1
Correction number 0
Part of message 1
Correction number 0
Part of message 1
Correction number 0
Part of message 0
Quality control % conf 70

BUFR SECTION 3

Length of section 3 (bytes) 28
Reserved 0
Number of data subsets 1
Flag (data type/data compression) 128

Data descriptors (unexpanded)

1 309007
2 222000
3 101000
4 031002
5 031031
6 001031
7 001201
8 101000
9 031002
10 033007

Data descriptors (expanded)
BUFR User’s Guide

1 007004 PRESSURE
2 008001 VERTICAL SOUNDING SIGNIFICANCE
3 010003 GEOPOTENTIAL
4 012001 TEMPERATURE/DRY BULB TEMPERATURE
5 012003 DEW POINT TEMPERATURE
6 011001 WIND DIRECTION
7 011002 WIND SPEED

STARTING SUBSET TO BE PRINTED : 1
ENDING SUBSET TO BE PRINTED : 1

EXPANDED BUFR MESSAGE

BUFR MESSAGE DATA TYPE 2
RDB DATA SUBTYPE 101
TOTAL BUFR LENGTH (BYTES) 860

1 PRESSURE 50000.0000 PA
2 VERTICAL SOUNDING SIGNIFICANCE 32.0000 FLAG TABLE 8001
3 GEOPOTENTIAL 57330.0000 M**2/S**2
4 TEMPERATURE/DRY 268.3000 K
5 DEW POINT TEMPERATURE 259.3000 K
6 WIND DIRECTION 70.0000 DEGREE TRUE
7 WIND SPEED 12.0000 M/S

The equivalent request in batch mode will be:

KREQ(1)=1
KREQ(2)=2
KRQL=7
KRQ(1)=007004 RQV(1)=50000.
KRQ(2)=008001 RQV(2)=RMISS
KRQ(3)=010003 RQV(3)=RMISS
KRQ(4)=012001 RQV(4)=RMISS
KRQ(5)=012003 RQV(5)=RMISS
KRQ(6)=011001 RQV(6)=RMISS
KRQ(7)=011002 RQV(7)=RMISS

where RMISS is missing value indicator RMISS=1.7E38

CALL BURQS(KREQ,KRQL,KRQ,RQV,KERR)

getting the same result as previously.
3.6 Printing routines

Bufr form is a binary representation of meteorological data and as such is not suitable for visualization. After expanding Bufr data using the BUFREX routine a number of printing routines can be used to print different parts of the Bufr message.

3.6.1 To print Section 0

CALL BUPRS0(KSEC0)

3.6.2 To print Section 1

CALL BUPRS1(KSEC1)

3.6.3 To print Section 2

Section 2 of the Bufr message is an optional section and every ADP centre can pack any information in this section. The Bufr software decodes this local information and stores it into KSEC2 array. ECMWF is storing RDB key in the Section 2 of the Bufr messages. To print content of the Section 2, subroutine BUUKEY must be called before the BUPRS2 routine. For other cases, special routines have to be written to unpack this information.

CALL BUUKEY(KSEC1,KSEC2,KEY,KSUP,KERR)

CALL BUPRS2(KSUP,KEY)

where

- KEY - An INTEGER array containing RDB key information
- The other arguments were described in previous routines.

KEY - An INTEGER array containing RDB key information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
</tbody>
</table>
| 2           | RDB type                       | continued on next page
<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>RDB subtype</td>
</tr>
<tr>
<td>4</td>
<td>Year</td>
</tr>
<tr>
<td>5</td>
<td>Month</td>
</tr>
<tr>
<td>6</td>
<td>Day</td>
</tr>
<tr>
<td>7</td>
<td>Hour</td>
</tr>
<tr>
<td>8</td>
<td>Minute</td>
</tr>
<tr>
<td>9</td>
<td>Second</td>
</tr>
<tr>
<td>10</td>
<td>Longitude 1</td>
</tr>
<tr>
<td>11</td>
<td>Latitude 1</td>
</tr>
<tr>
<td>12</td>
<td>Longitude 2</td>
</tr>
<tr>
<td>13</td>
<td>Latitude 2</td>
</tr>
<tr>
<td>14</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>15</td>
<td>Ident (numeric as satellite number)</td>
</tr>
<tr>
<td>16</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>17</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>18</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>19</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>20</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>21</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>22</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>23</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>24</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>25</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>26</td>
<td>Day (RDB insertion)</td>
</tr>
<tr>
<td>27</td>
<td>Hour (RDB insertion)</td>
</tr>
<tr>
<td>28</td>
<td>Minute (RDB insertion)</td>
</tr>
<tr>
<td>29</td>
<td>Second (RDB insertion)</td>
</tr>
<tr>
<td>30</td>
<td>Day (MDB insertion)</td>
</tr>
<tr>
<td>31</td>
<td>Hour MDB insertion</td>
</tr>
<tr>
<td>32</td>
<td>Minute (MDB insertion)</td>
</tr>
<tr>
<td>33</td>
<td>Second (MDB insertion)</td>
</tr>
<tr>
<td>34</td>
<td>Correction number</td>
</tr>
<tr>
<td>35</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>36</td>
<td>Not used</td>
</tr>
<tr>
<td>37</td>
<td>Correction number</td>
</tr>
<tr>
<td>38</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>39</td>
<td>Not used</td>
</tr>
<tr>
<td>40</td>
<td>Correction number</td>
</tr>
</tbody>
</table>

continued on next page
### 3.6 Printing routines

#### 3.6.4 To print Section 3

Prior to calling the BUPRS3 routine, the BUSEL routine has to be called to get lists of unexpanded and fully expanded Data descriptors.

```fortran
CALL BUSEL(KTDLEN, KTDLST, KTDEXL, KTDEXP, KERR)
CALL BUPRS3(KSEC3, KTDLEN, KTDLST, KTDEXL, KTDEXP, KELEM, CNAMES)
```

#### 3.6.5 To print data

```fortran
CALL BUPRT(K, KSUB1, KSUB2, KELEM, CNAMES, CUNITS, CVALS, KVALS, VALUES, KSUP, KSEC1, KERR)
```

where

- **K** - An INTEGER set to 0 - No Code table entry
  1 - Code table entry
- **KSUB1** - An INTEGER containing the starting subset to print.
- **KSUB2** - An INTEGER containing the ending subset to print.
- **KELEM** - An INTEGER containing the expected number of expanded elements.
- **CNAMES** - A CHARACTER*64 array containing the element names.
- **CUNITS** - A CHARACTER*24 array containing the units.
- **CVALS** - A CHARACTER*80 array containing character values.
- **KVALS** - An INTEGER containing the expected number of data values.
- **VALUES** - A REAL*8 array containing the expanded values.
- **KSUP** - AN INTEGER array containing supplementary information.
- **KSEC1** - An INTEGER array containing Section 1 information.
- **KERR** - An INTEGER containing an error code.
3.7 Bufr software tools

3.7.1 Subroutine BUS012

Purpose

Expands only Sections 0, 1 and 2 of Bufr message.

Interface

CALL BUS012(KBUFL,KBUFF,KSUP,KSEC0,KSEC1,KSEC2,KERR)

where

• Integer variables are denoted by first letter K.

Input arguments

• KBUFL - An INTEGER variable containing the length of Bufr message in words.
• KBUFF - An INTEGER array containing the Bufr message.

Output argument

• KSUP - An INTEGER array size 9 containing supplementary information
• KSEC0 - An INTEGER array size 3 containing Bufr Section 0 information
• KSEC1 - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly.
• KSEC2 - An INTEGER array of 64 words containing Bufr Section 2 information. ECMWF uses this section to store Report Data Base key.
• KERR - An Integer containing an error code.
**KSUP**  AN INTEGER array containing supplementary information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dimension of KSEC1 array</td>
</tr>
<tr>
<td>2</td>
<td>Dimension of KSEC2 array</td>
</tr>
<tr>
<td>3</td>
<td>Dimension of KSEC3 array</td>
</tr>
<tr>
<td>4</td>
<td>Dimension of KSEC4 array</td>
</tr>
<tr>
<td>5</td>
<td>Real number of expanded elements</td>
</tr>
<tr>
<td>6</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>7</td>
<td>Real number of elements in CVALS array</td>
</tr>
<tr>
<td>8</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>9</td>
<td>Dimension of KSEC0 array</td>
</tr>
</tbody>
</table>

**KSEC0**  An INTEGER array size 3 containing Bufr Section 0 information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 0 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Total length of Bufr message in bytes</td>
</tr>
<tr>
<td>3</td>
<td>Bufr Edition number</td>
</tr>
</tbody>
</table>

**KSEC1**  An INTEGER array of at least 40 words containing Bufr Section 1

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 1 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Bufr Edition number</td>
</tr>
<tr>
<td>3</td>
<td>Originating centre</td>
</tr>
<tr>
<td>4</td>
<td>Update sequence number</td>
</tr>
<tr>
<td>5</td>
<td>Flag (presence of Section 2 in the message)</td>
</tr>
<tr>
<td>6</td>
<td>Bufr message type ( Bufr Table A)</td>
</tr>
<tr>
<td>7</td>
<td>Bufr message subtype (local use)</td>
</tr>
<tr>
<td>8</td>
<td>Version number of local table used</td>
</tr>
<tr>
<td>9</td>
<td>Century year</td>
</tr>
<tr>
<td>10</td>
<td>Month</td>
</tr>
<tr>
<td>11</td>
<td>Day</td>
</tr>
<tr>
<td>12</td>
<td>Hour</td>
</tr>
<tr>
<td>13</td>
<td>Minute</td>
</tr>
<tr>
<td>14</td>
<td>Bufr Master Table used</td>
</tr>
<tr>
<td>15</td>
<td>Version number of Master table used</td>
</tr>
<tr>
<td>16</td>
<td>Originating sub-centre</td>
</tr>
<tr>
<td>18-</td>
<td>Local ADP centre information (byte by byte)</td>
</tr>
</tbody>
</table>

**KSEC2**  An INTEGER array of 64 words containing Bufr Section 2
<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2-</td>
<td>Report Data Base key in packed form</td>
</tr>
</tbody>
</table>

**Method**

None.

**Externals**

- BUEXS0 - Expands Section 0 of Bufr message
- BUEXS1 - Expands Section 1 of Bufr message
- BUEXS2 - Expands Section 2 of Bufr message

**Reference**

None.
### Subroutine BUSEL

**Purpose**

Returns lists of unexpanded and expanded data descriptors from the Bufr message. The lists contain Bufr Table D sequence numbers, and the Bufr Table B reference numbers.

**Interface**

```plaintext
CALL BUSEL(KTDLLEN, KTDLST, KTDEXL, KTDEXP, KERR)
```

where

- Integer variables are denoted by first letter K.

**Input arguments**

- None.

**Output arguments**

- KTDLLEN - An INTEGER variable containing number of data descriptors in KTDLST array
- KTDLST - An INTEGER array containing the list of KTDLLEN data descriptors
- KTDEXL - An INTEGER variable containing number of expanded data descriptors
- KTDEXP - An INTEGER array containing the list of KTDEXL data descriptors
- KERR - An INTEGER containing error code.

**Method**

- None

**Externals**

- None

**Reference**

- None
3.7.3 Subroutine BUUKEY

Purpose

Unpacks ECMWF Report Data Base Key.

Interface

CALL BUUKEY(KSEC1,KSEC2,KEY,KSUP,KERR)

where: zz

- Integer variables are denoted by first letter K.

Input arguments

- KSEC1 - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly.

- KSEC2 - An INTEGER array of 64 words containing Bufr Section 2 information. ECMWF uses this section to store Report Data Base Key.

- KSUP - An INTEGER array (size 9) containing supplementary information.

**KSEC1** An INTEGER array of at least 40 words containing Bufr Section 1

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of section 1 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Bufr Edition number</td>
</tr>
<tr>
<td>3</td>
<td>Originating centre</td>
</tr>
<tr>
<td>4</td>
<td>Update sequence number</td>
</tr>
<tr>
<td>5</td>
<td>Flag (presence of Section 2 in the message)</td>
</tr>
<tr>
<td>6</td>
<td>Bufr message type (Bufr Table A)</td>
</tr>
<tr>
<td>7</td>
<td>Bufr message subtype (local use)</td>
</tr>
<tr>
<td>8</td>
<td>Version number of local table used</td>
</tr>
<tr>
<td>9</td>
<td>Century year</td>
</tr>
<tr>
<td>10</td>
<td>Month</td>
</tr>
<tr>
<td>11</td>
<td>Day</td>
</tr>
<tr>
<td>12</td>
<td>Hour</td>
</tr>
<tr>
<td>13</td>
<td>Minute</td>
</tr>
<tr>
<td>14</td>
<td>Bufr Master Table used</td>
</tr>
<tr>
<td>15</td>
<td>Version number of Master table used</td>
</tr>
<tr>
<td>16</td>
<td>Originating sub-centre</td>
</tr>
<tr>
<td>18-</td>
<td>Local ADP centre information (byte by byte)</td>
</tr>
</tbody>
</table>
3.7 Bufr software tools

**KSEC2**  An INTEGER array of 64 words containing Bufr Section 2

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Report Data Base key in packed form</td>
</tr>
</tbody>
</table>

**KSUP**  An INTEGER array size 9 containing supplementary information

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dimension of KSEC1 array</td>
</tr>
<tr>
<td>2</td>
<td>Dimension of KSEC2 array</td>
</tr>
<tr>
<td>3</td>
<td>Dimension of KSEC3 array</td>
</tr>
<tr>
<td>4</td>
<td>Dimension of KSEC4 array</td>
</tr>
<tr>
<td>5</td>
<td>Real number of expanded elements</td>
</tr>
<tr>
<td>6</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>7</td>
<td>Real number of elements in CVALS array</td>
</tr>
<tr>
<td>8</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>9</td>
<td>Dimension of KSEC0 array</td>
</tr>
</tbody>
</table>

**Output arguments**

- **KEY** - An INTEGER array of 46 words containing unpacked RDB key.
- **KERR** - Error code

**KEY**  - An INTEGER array of 46 words containing unpacked RDB key.

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>RDB type</td>
</tr>
<tr>
<td>3</td>
<td>RDB subtype</td>
</tr>
<tr>
<td>4</td>
<td>Year</td>
</tr>
<tr>
<td>5</td>
<td>Month</td>
</tr>
<tr>
<td>6</td>
<td>Day</td>
</tr>
<tr>
<td>7</td>
<td>Hour</td>
</tr>
<tr>
<td>8</td>
<td>Minute</td>
</tr>
<tr>
<td>9</td>
<td>Second</td>
</tr>
<tr>
<td>10</td>
<td>Longitude 1</td>
</tr>
</tbody>
</table>

*continued on next page*
<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Latitude 1</td>
</tr>
<tr>
<td>12</td>
<td>Longitude 2</td>
</tr>
<tr>
<td>13</td>
<td>Latitude 2</td>
</tr>
<tr>
<td>14</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>15</td>
<td>Ident (numeric as satellite number)</td>
</tr>
<tr>
<td>16</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>17</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>18</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>19</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>20</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>21</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>22</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>23</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>24</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>25</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>26</td>
<td>Day (RDB insertion)</td>
</tr>
<tr>
<td>27</td>
<td>Hour (RDB insertion)</td>
</tr>
<tr>
<td>28</td>
<td>Minute (RDB insertion)</td>
</tr>
<tr>
<td>29</td>
<td>Second (RDB insertion)</td>
</tr>
<tr>
<td>30</td>
<td>Day (MDB insertion)</td>
</tr>
<tr>
<td>31</td>
<td>Hour MDB insertion</td>
</tr>
<tr>
<td>32</td>
<td>Minute (MDB insertion)</td>
</tr>
<tr>
<td>33</td>
<td>Second (MDB insertion)</td>
</tr>
<tr>
<td>34</td>
<td>Correction number</td>
</tr>
<tr>
<td>35</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>36</td>
<td>Not used</td>
</tr>
<tr>
<td>37</td>
<td>Correction number</td>
</tr>
<tr>
<td>38</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>39</td>
<td>Not used</td>
</tr>
<tr>
<td>40</td>
<td>Correction number</td>
</tr>
<tr>
<td>41</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>42</td>
<td>Not used</td>
</tr>
<tr>
<td>43</td>
<td>Correction number</td>
</tr>
<tr>
<td>44</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>45</td>
<td>Not used</td>
</tr>
<tr>
<td>46</td>
<td>The lowest quality control % confidence</td>
</tr>
</tbody>
</table>

**Method**

The latitudes and longitudes are unpacked and stored as integers. To get real values apply the following
calculation:

\[
\begin{align*}
RLAT1 &= (KEY(11) - 9000000)/100000. \\
RLON1 &= (KEY(10) - 18000000)/100000. \\
RLAT2 &= (KEY(13) - 9000000)/100000. \\
RLON2 &= (KEY(12) - 18000000)/100000. \\
\end{align*}
\]

**Externals**

- **BUNPCK**  - Unpack Bit pattern
- **BUNPKS**  - Unpacks bit pattern in repeated way

**Reference**

None.
3.7.4 Subroutine BUPKEY

Purpose

Packs ECMWF RDB Key into KSEC2 array.

Interface

CALL BUPKEY(KEY, KSEC1, KSEC2, KERR)

where:

- Integer variables are denoted by first letter K.

Input arguments

- KEY - An INTEGER array of 46 words containing unpacked RDB
- KSEC1 - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly.
- KSEC2 - An INTEGER array of 64 words containing Bufr Section 2.

KEY An INTEGER array of 46 words containing unpacked RDB key.

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>RDB type</td>
</tr>
<tr>
<td>3</td>
<td>RDB subtype</td>
</tr>
<tr>
<td>4</td>
<td>Year</td>
</tr>
<tr>
<td>5</td>
<td>Month</td>
</tr>
<tr>
<td>6</td>
<td>Day</td>
</tr>
<tr>
<td>7</td>
<td>Hour</td>
</tr>
<tr>
<td>8</td>
<td>Minute</td>
</tr>
<tr>
<td>9</td>
<td>Second</td>
</tr>
<tr>
<td>10</td>
<td>Longitude 1</td>
</tr>
<tr>
<td>10</td>
<td>Latitude 1</td>
</tr>
</tbody>
</table>

continued on next page
3.7 Bufr software tools

continued from previous page

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Longitude 2</td>
</tr>
<tr>
<td>13</td>
<td>Latitude 2</td>
</tr>
<tr>
<td>14</td>
<td>Number of subsets</td>
</tr>
<tr>
<td>15</td>
<td>Ident (numeric as satellite number)</td>
</tr>
<tr>
<td>16</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>17</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>18</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>19</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>20</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>21</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>22</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>23</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>24</td>
<td>Ident (CCITTIA5) one character</td>
</tr>
<tr>
<td>25</td>
<td>Total Bufr message length in bytes</td>
</tr>
<tr>
<td>26</td>
<td>Day (RDB insertion)</td>
</tr>
<tr>
<td>27</td>
<td>Hour (RDB insertion)</td>
</tr>
<tr>
<td>28</td>
<td>Minute (RDB insertion)</td>
</tr>
<tr>
<td>29</td>
<td>Second (RDB insertion)</td>
</tr>
<tr>
<td>30</td>
<td>Day (MDB insertion)</td>
</tr>
<tr>
<td>31</td>
<td>Hour MDB insertion</td>
</tr>
<tr>
<td>32</td>
<td>Minute (MDB insertion)</td>
</tr>
<tr>
<td>33</td>
<td>Second (MDB insertion)</td>
</tr>
<tr>
<td>34</td>
<td>Correction number</td>
</tr>
<tr>
<td>35</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>36</td>
<td>Not used</td>
</tr>
<tr>
<td>37</td>
<td>Correction number</td>
</tr>
<tr>
<td>38</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>39</td>
<td>Not used</td>
</tr>
<tr>
<td>40</td>
<td>Correction number</td>
</tr>
<tr>
<td>41</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>42</td>
<td>Not used</td>
</tr>
<tr>
<td>43</td>
<td>Correction number</td>
</tr>
<tr>
<td>44</td>
<td>Part received (for TEMP/PILOT observations)</td>
</tr>
<tr>
<td>45</td>
<td>Not used</td>
</tr>
<tr>
<td>46</td>
<td>The lowest quality control % confidence</td>
</tr>
</tbody>
</table>

**KSEC1** The content of the KSEC1 array is given in the following Table:
<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 1 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Bufr Edition number</td>
</tr>
<tr>
<td>3</td>
<td>Originating centre</td>
</tr>
<tr>
<td>4</td>
<td>Update sequence number</td>
</tr>
<tr>
<td>5</td>
<td>Flag (presence of Section 2 in the message)</td>
</tr>
<tr>
<td>6</td>
<td>Bufr message type (Bufr Table A)</td>
</tr>
<tr>
<td>7</td>
<td>Bufr message subtype (local use)</td>
</tr>
<tr>
<td>8</td>
<td>Version number of local table used</td>
</tr>
<tr>
<td>9</td>
<td>Century year</td>
</tr>
<tr>
<td>10</td>
<td>Month</td>
</tr>
<tr>
<td>11</td>
<td>Day</td>
</tr>
<tr>
<td>12</td>
<td>Hour</td>
</tr>
<tr>
<td>13</td>
<td>Minute</td>
</tr>
<tr>
<td>14</td>
<td>Bufr Master Table used</td>
</tr>
<tr>
<td>15</td>
<td>Version number of Master table used</td>
</tr>
<tr>
<td>16</td>
<td>Originating sub-centre</td>
</tr>
<tr>
<td>18-</td>
<td>Local ADP centre information (byte by byte)</td>
</tr>
</tbody>
</table>

**KSEC2**  The content of the KSEC2 array is given in the following Table:

<table>
<thead>
<tr>
<th>Array index</th>
<th>Word content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Section 2 in bytes</td>
</tr>
<tr>
<td>2</td>
<td>Report Data Base key in packed form</td>
</tr>
</tbody>
</table>

**Output arguments**

- **KERR** - Error code

**Method**

The integer values in the KEY array for latitude and longitude must be calculated as:

\[
\begin{align*}
\text{KEY}(10) &= \text{NINT} (\text{RLON1} \times 100000. + 18000000) \\
\text{KEY}(11) &= \text{NINT} (\text{RLAT1} \times 100000. + 9000000) \\
\text{KEY}(12) &= \text{NINT} (\text{RLON2} \times 100000. + 18000000) \\
\text{KEY}(13) &= \text{NINT} (\text{RLAT2} \times 100000. + 9000000)
\end{align*}
\]

**Externals**

- **BUPCK** - Packs bit pattern
Subroutine BUXDES

Purpose

A basic principle in encoding Bufr data is to have a one to one correspondence between data descriptors and the values to be packed.

This routine is a tool to achieve this requirement. It expands Data descriptors and prints unexpanded and expanded lists. The Unexpanded list should be part of Section 3 of the Bufr message and the VALUES array ought to be filled with element values corresponding to the expanded data descriptors.

Interface

CALL BUXDES(K,KSEC1,KTDLEN,KTDLST,KDLEN,KDATA,KELEM,
            KTDEXL,KTDEXP,CNAMES,CUNITS,KERR)

where:

- Integer variables are denoted by first letter K.
- Character variables are denoted by first letter C.

Input arguments

- K - An INTEGER variable containing 0 - no print 1 - print
- KSEC1 - An INTEGER array of at least 40 words containing Bufr Section 1 information. When Section 1 contains data for local use, KSEC1 should be sized accordingly. The following words of KSEC1 must be filled:
  - KSEC1(2) - Bufr Edition number
  - KSEC1(3) - Originating centre
  - KSEC1(8) - Version number of local tables used
  - KSEC1(15) - Version number of Master table used
- KTDLEN - An INTEGER containing number of data descriptors
- KTDLST - An INTEGER array containing data descriptors for Bufr Section 3
- KDLEN - An INTEGER containing dimension of array KDATA
- KDATA - An INTEGER array containing delayed replication factors in the order they appear in the expanded list
- KELEM - An INTEGER containing expected number of expanded elements
Output arguments

- KTDEXL - An INTEGER containing number of expanded elements.
- KTDEXP - An INTEGER array containing list of expanded elements.
- CNAMEs - CHARACTER*64 array containing list names of expanded element
- CUNITs - Character*24 array containing list of units for expanded elements
- KERR - Return error code.

Method

None.

Externals

- BUETAB - Loads required Bufr tables.
- BUEDD - Expands data descriptors

Reference

None.
3.7 Bufr software tools

3.7.6 Subroutine BUBOX

Purpose

The expanded Bufr message can be very lengthy containing many bit maps referring backwards to the data. This routine resolves bit maps for the user, returning two dimensional arrays containing the expanded observation and the corresponding applications (quality controls, statistics, differences e.t.c). Every application appears as a new column. A new data are following each other in the first column, starting with the generating centre/application information.

Interface

CALL BUBOX(KSUB, KSUP, KELEM, KWTR, CNAMES, CUNITS, KVALS, VALUES, KBOX, KAPP, KLEN, KBOXR, VALS, CBOXN, CBOXU, KERR)

where:

- Integer variables are denoted by first letter K.
- Real variable are denoted by first letter V.
- Character variables are denoted by first letter C.

Input arguments

- KSUB - An INTEGER containing subset number.
- KSUP - An INTEGER array size 9 containing supplementary information.
- KELEM - An INTEGER variable containing expected number of expanded elements. It must be the same as used in BUFREX routine previously called.
- KWTR - An INTEGER array containing list of expanded Bufr table B reference numbers (KTDEXP output from BUSEL routine).
- CNAMES - A CHARACTER*64 array of KELEM words containing element names.
- CUNITS - A CHARACTER*24 array of KELEM words containing element units.
- KVALS - An INTEGER variable containing expected number of data values.
- VALUES - A REAL*8 array of KVALS words containing element values.
Output arguments

- **KBOX** - An INTEGER containing number of elements in first column of box.
- **KAPP** - An INTEGER containing number of applications
- **KLEN** - An INTEGER containing max index for number of rows. The next column starts at KLEN +1 element or index=i + (KAPP - 1)*KLEN to address any value in the box.
- **KBOXR** - An INTEGER array of 80000 containing Bufr table B reference numbers.
- **VALS** - A REAL*8 array of 80000 containing boxed values.
- **CBOXN** - A CHARACTER*64 array of 80000 containing boxed element names.
- **CBOXU** - A CHARACTER*24 array of 80000 containing boxed units.
- **KERR** - An INTEGER containing error code

Method

The expanded Bufr message is passed in the subroutine to resolve backward reference bit maps associating all applications to the particular element. The output arrays containing boxed data are one dimensional arrays containing information as two dimensional table.

The first column contains in first 6 rows reserved information and the original observation starts at the index 7. Columns 2- KAPP are different generating applications corresponding through bit maps to the data in the column 1. Column 1 contains KLEN elements. Index to the i-th element can be calculated as:

\[ \text{index} = i + (KAPP-1) \times KLEN \]

The first raw, columns 2 to KAPP contain quality control operators (222000, 225000 e.t.c) Rows 2 to 6, columns 2 to KAPP contain generating centre, generating application, statistics, incremental update number and minimisation simulation number respectively.

Externals

- **BUERR** - Prints error

Reference

- None.
3.7.7 Subroutine BUPRTBOX

**Purpose**

Prints boxed expanded Bufr message.

**Interface**

```plaintext
CALL BUPRTBOX(KBOX, KAPP, KLEN, KBOXR, VALS, CBOXN, CBOXU)
```

**Input arguments**

- **KBOX** - An INTEGER containing number of elements in first column of box.
- **KAPP** - An INTEGER containing number of applications
- **KLEN** - An INTEGER containing max index for number of rows. The next column starts at KLEN +1 element or index=i+(KAPP-1)*KLEN to address any value in the box.
- **KBOXR** - An INTEGER array containing Bufr table B reference numbers.
- **VALS** - A REAL*8 array containing boxed values.
- **CBOXN** - A CHARACTER*64 array containing boxed element names.
- **CBOXU** - A CHARACTER*24 array containing boxed units.

**Output arguments**

None.

**Method**

None.

**Externals**

None.

**Reference**

None.
3.8 Performance

The speed to decode Bufr messages is proportional to the number of messages. Since the same number of the same kind of observations can be packed into Bufr form in many ways, it is recommended to use multi subsets in compressed form whenever possible. To get the best performance from the software it is recommended that:

- The input file for expansion should contain Bufr messages sorted according to their types.
- Avoid usage of delayed data descriptor replication factors if possible.
- Avoid usage of Operator 203yyy to change reference values.
- Encode data into Bufr form in multi subset compressed form.

Here are some figures of real times used on IBM RS600, single processor computer to expand:

- All conventional data for one analysis cycle (56945 Bufr messages, 197696 subsets) 18 seconds.
- All AIRS data for one analysis cycle (70 Mbytes, 7775 bufr messages with 80563 subsets) 122 seconds.
4 Quality control in BUFR

A quality control information in the Bufr shall be represented using Quality control operators from the Bufr Table C. Table 9 contains definition of possible operators and their usage.

Table 9: Bufr Tables C quality control operators

<table>
<thead>
<tr>
<th>Table Reference F X</th>
<th>Operand</th>
<th>Operator name</th>
<th>Operation definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 22</td>
<td>000</td>
<td>Quality information</td>
<td>The Class 33 quality information which follows relates to the following N fully expanded (including all replications) data descriptors; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data by the replicated 031031 descriptor shall indicate those elements for which quality control information is given.</td>
</tr>
<tr>
<td>2 23</td>
<td>000</td>
<td>Substituted values operator</td>
<td>The substituted values which follow relate to the previous N fully expanded (including all replications) data descriptors; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data by the replicated 031031 descriptor shall indicate those elements for which substituted values are given.</td>
</tr>
<tr>
<td>2 23</td>
<td>255</td>
<td>Substituted value marker operator</td>
<td>This operator shall indicate the relative position of the data element in the data stream where the descriptor(s) indicated as relevant by the 031031 descriptor shall have effect. This device allows for additional descriptors (and data) to be placed after the 031031 descriptor (and its associated bit map in the data) without losing the correspondence between the original descriptors and the substituted values.</td>
</tr>
<tr>
<td>2 24</td>
<td>000</td>
<td>First order statistical values follow</td>
<td>The statistical values which follow relate to the previous N fully expanded (including all replications) data descriptors; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data described by the replicated 031031 descriptor shall indicate those elements for which statistical values are given; each statistical value shall be represented in the data according to the scheme described by the corresponding data descriptor, as possibly modified by any operator having scope over that descriptor when first used.</td>
</tr>
</tbody>
</table>

continued on next page
<table>
<thead>
<tr>
<th>Table Reference F X</th>
<th>Operand</th>
<th>Operator name</th>
<th>Operation definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 24</td>
<td>255</td>
<td>First order statistical values marker operator</td>
<td>This operator shall indicate the relative position of the data element in the data stream where the descriptor(s) indicated as relevant by the 031031 operator shall have effect. This device allows for additional descriptors (and data) to be placed after the 031031 descriptor (and its associated bit map in the data) without losing the correspondence between the original descriptors and the statistical values.</td>
</tr>
<tr>
<td>2 25</td>
<td>000</td>
<td>Difference statistical values follow</td>
<td>The statistical values which follow relate to the previous N fully expanded (including all replications) data descriptors; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data by the replicated 031031 descriptor shall indicate those elements for which statistical values are given; each statistical value shall be represented in the data according to the scheme described by the corresponding data descriptor, as possibly modified by any operator having scope over that descriptor when first used, but with a reference value of (-2^n) and data width of ((n+1)), where (n) is the data width given by the original descriptor. This special reference value allows the statistical difference values to be centred around zero.</td>
</tr>
<tr>
<td>2 25</td>
<td>255</td>
<td>Difference statistical values marker operator</td>
<td>This operator shall indicate the relative position of the data element in the data stream where the descriptor(s) indicated as relevant by the 031031 operator shall have effect. This device allows for additional descriptors (and data) to be placed after the 031031 descriptor (and its associated bit map in the data) without losing the correspondence between the original descriptors and the statistical values.</td>
</tr>
<tr>
<td>2 32</td>
<td>000</td>
<td>Replaced/ retained values follow</td>
<td>The replaced retained values which follow relate to the previous N fully expanded (including all replications) data descriptors; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data by the replicated 031031 descriptor shall indicate those elements for which replace/retained values are given.</td>
</tr>
<tr>
<td>Table Reference FX</td>
<td>Operand</td>
<td>Operator name</td>
<td>Operation definition</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td>----------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2 32</td>
<td>255</td>
<td>Replaced/retained value marker operator</td>
<td>This operator shall indicate the relative position of the data element in the data stream where the descriptor(s) indicated as relevant by the 031031 operator shall have effect. This device allows for additional descriptors (and data) to be placed after the 031031 descriptor (and its associated bit map in the data) without losing the correspondence between the original descriptors and the replaced/retained values.</td>
</tr>
<tr>
<td>2 35</td>
<td>000</td>
<td>Cancel backward data reference</td>
<td>This operator terminates all previously define backward references.</td>
</tr>
<tr>
<td>2 36</td>
<td>000</td>
<td>Define backward reference bit map</td>
<td>This operator is used when defining backward reference bit maps which are likely to be reused; this operator shall be followed by a replication operator and the data present indicator (031031); the replication factor shall define N, while the bit map defined within the data by the replicated 031031 descriptor shall indicate the elements selected.</td>
</tr>
<tr>
<td>2 37</td>
<td>000</td>
<td>Used defined bit map</td>
<td>This operator may be used instead of the sequence &quot;replication operator followed by data present indicator (031031)&quot;; use of this operator shall indicate that the bit map defined by the operator 236000 be used again.</td>
</tr>
<tr>
<td>2 37</td>
<td>255</td>
<td>Cancel use defined bit map</td>
<td>This operator cancels the reuse of a previously defined bit map.</td>
</tr>
</tbody>
</table>
4.1 Quality control example

Bufr message containing analysis feedback data was expanded. List of descriptors in the section 3 shows how to use quality control operators to represent various quality controls and statistics. The output contains following information:

BUFR DECODING SOFTWARE VERSION - 2.0

Your path for Bufr tables is:
/home/ecmwf/emos_sms/tables/BUFR/test/
BUFR Tables to be loaded B000980201,C000980201,D000980201

BUFR SECTION 0
Length of section 0 (bytes) 8
Total length of Bufr message (bytes) 382
Bufr Edition number 2

BUFR SECTION 1
Length of section 1 (bytes) 18
Bufr Edition number 2
Originating centre 98
Update sequence number 1
Flag (presence of section 2) 128
Bufr message type 4
Bufr message subtype 142
Version number of local table 1
Year 94
Month 9
Day 5
Hour 10
Minute 51
Version number of Master table 2
Bufr Master table 0

BUFR SECTION 2
Length of section 2 52
Report Data Base Key

RDB data type 7
RDB data subtype 142
Year 1994
Month 9
Day 5
Hour 10
Minute 51
Second 0
Latitude 1 79.00
Longitude 1 -60.00
Identifier FIN147
Total Bufr message length 382
Day (RDB insertion) 5
Hour (RDB insertion) 11
Minute (RDB insertion) 35
Second (RDB insertion) 42
Day (MDB arrival) 5
Hour (MDB arrival) 11
Minute (MDB arrival) 35
Second (MDB arrival) 25
Correction number 0
Part of message 1
Correction number 0
Part of message 0
Correction number 0
Part of message 0
Correction number 0
Part of message 0
Quality control % conf 70

BUFR SECTION 3
4.1 Quality control example

Length of section 3 (bytes) 148
Reserved 0
Number of data subsets 1
Flag (data type/data compression) 128

Data descriptors (unexpanded)

1 311001
2 222000
3 101018
4 031031
5 001031
6 001201
7 101012
8 033007
9 001031
10 001201
11 033200
12 033201
13 235000
14 001031
15 001201
16 007004
17 011003
18 011004
19 010195
20 012001
21 222000
22 236000
23 101004
24 031031
25 001031
26 001201
27 101004
28 033002
29 222000
30 237000
31 001031
32 001201
33 101004
34 033002
35 222000
36 237000
37 001031
38 001201
39 101004
40 033202
41 222000
42 237000
43 001031
44 001201
45 101004
46 033203
47 222000
48 237000
49 001031
50 001201
51 101004
52 033204
53 225000
54 237000
55 001031
56 008024
57 101004
58 225255
59 225000
60 237000
61 001031
62 008024
63 101004
64 225255
65 225000
66 237000
67 001031
68 008024
69 101004
70 225255

Data descriptors (expanded)

1 001006 AIRCRAFT IDENTIFIER
2 002061 AIRCRAFT NAVIGATIONAL SYSTEM
3 004001 YEAR
4 004002 MONTH
5 004003 DAY
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>004004 HOUR</td>
</tr>
<tr>
<td>7</td>
<td>004005 MINUTE</td>
</tr>
<tr>
<td>8</td>
<td>005001 LATITUDE (HIGH ACCURACY)</td>
</tr>
<tr>
<td>9</td>
<td>006001 LONGITUDE (HIGH ACCURACY)</td>
</tr>
<tr>
<td>10</td>
<td>008004 PHASE OF AIRCRAFT FLIGHT</td>
</tr>
<tr>
<td>11</td>
<td>007002 HEIGHT OR ALTITUDE</td>
</tr>
<tr>
<td>12</td>
<td>012001 TEMPERATURE/DRY BULB TEMPERATURE</td>
</tr>
<tr>
<td>13</td>
<td>011001 WIND DIRECTION</td>
</tr>
<tr>
<td>14</td>
<td>011002 WIND SPEED</td>
</tr>
<tr>
<td>15</td>
<td>011031 DEGREE OF TURBULENCE</td>
</tr>
<tr>
<td>16</td>
<td>011032 HEIGHT OF BASE OF TURBULENCE</td>
</tr>
<tr>
<td>17</td>
<td>011033 HEIGHT OF TOP OF TURBULENCE</td>
</tr>
<tr>
<td>18</td>
<td>020041 AIRFRAME ICING</td>
</tr>
<tr>
<td>19</td>
<td>222000 QUALITY INFORMATION FOLLOW</td>
</tr>
<tr>
<td>20</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>21</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>22</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>23</td>
<td>031031 DATA PRESENT INDICATOR</td>
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<tr>
<td>24</td>
<td>031031 DATA PRESENT INDICATOR</td>
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<td>25</td>
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<td>28</td>
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<td>031031 DATA PRESENT INDICATOR</td>
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<td>32</td>
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<td>33</td>
<td>031031 DATA PRESENT INDICATOR</td>
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<tr>
<td>34</td>
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<td>35</td>
<td>031031 DATA PRESENT INDICATOR</td>
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<tr>
<td>36</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>37</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>38</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>39</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>40</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>41</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>42</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>43</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>44</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>45</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>46</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>47</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>48</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>49</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>50</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>51</td>
<td>033007 % CONFIDENCE</td>
</tr>
<tr>
<td>52</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>53</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>54</td>
<td>033200 ANALYSIS REPORT EVENTS</td>
</tr>
<tr>
<td>55</td>
<td>033201 ANALYSIS REPORT STATUS EVENT</td>
</tr>
<tr>
<td>56</td>
<td>235000 CANCEL BACKWARD DATA REFERENCE</td>
</tr>
<tr>
<td>57</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>58</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>59</td>
<td>001004 U-COMPONENT</td>
</tr>
<tr>
<td>60</td>
<td>001004 V-COMPONENT</td>
</tr>
<tr>
<td>61</td>
<td>001004 W-COMPONENT</td>
</tr>
<tr>
<td>62</td>
<td>01957 HEADING (HIGH ACCURACY)</td>
</tr>
<tr>
<td>63</td>
<td>012001 TEMPERATURE/DRY BULB TEMPERATURE</td>
</tr>
<tr>
<td>64</td>
<td>222000 QUALITY INFORMATION FOLLOW</td>
</tr>
<tr>
<td>65</td>
<td>236000 BACKWARD REFERENCE BIT MAP</td>
</tr>
<tr>
<td>66</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>67</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>68</td>
<td>031031 DATA PRESENT INDICATOR</td>
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<tr>
<td>69</td>
<td>031031 DATA PRESENT INDICATOR</td>
</tr>
<tr>
<td>70</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>71</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>72</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>73</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>74</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>75</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>76</td>
<td>222000 QUALITY INFORMATION FOLLOW</td>
</tr>
<tr>
<td>77</td>
<td>237000 USE PREVIOUSLY DEFINED BIT MAP</td>
</tr>
<tr>
<td>78</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>79</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>80</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>81</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>82</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>83</td>
<td>033002 QUALITY INFORMATION TABLE</td>
</tr>
<tr>
<td>84</td>
<td>222000 QUALITY INFORMATION FOLLOW</td>
</tr>
<tr>
<td>85</td>
<td>237000 USE PREVIOUSLY DEFINED BIT MAP</td>
</tr>
<tr>
<td>86</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>87</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>88</td>
<td>033202 ANALYSIS DATUM EVENT FLAGS (1)</td>
</tr>
<tr>
<td>89</td>
<td>033202 ANALYSIS DATUM EVENT FLAGS (1)</td>
</tr>
<tr>
<td>90</td>
<td>033202 ANALYSIS DATUM EVENT FLAGS (1)</td>
</tr>
<tr>
<td>91</td>
<td>033202 ANALYSIS DATUM EVENT FLAGS (1)</td>
</tr>
<tr>
<td>92</td>
<td>222000 QUALITY INFORMATION FOLLOW</td>
</tr>
<tr>
<td>93</td>
<td>237000 USE PREVIOUSLY DEFINED BIT MAP</td>
</tr>
<tr>
<td>94</td>
<td>001031 GENERATING CENTRE</td>
</tr>
<tr>
<td>95</td>
<td>001201 GENERATING APPLICATION</td>
</tr>
<tr>
<td>96</td>
<td>033203 ANALYSIS DATUM EVENT FLAGS (2)</td>
</tr>
<tr>
<td>97</td>
<td>033203 ANALYSIS DATUM EVENT FLAGS (2)</td>
</tr>
<tr>
<td>98</td>
<td>033203 ANALYSIS DATUM EVENT FLAGS (2)</td>
</tr>
</tbody>
</table>
4.1 Quality control example

99 033203 ANALYSIS DATUM EVENT FLAGS (2)
100 220000 QUALITY INFORMATION FOLLOW
101 237000 USE PREVIOUSLY DEFINED BIT MAP
102 001031 GENERATING CENTRE
103 001201 GENERATING APPLICATION
104 033204 ANALYSIS DATUM STATUS FLAGS
105 033204 ANALYSIS DATUM STATUS FLAGS
106 033204 ANALYSIS DATUM STATUS FLAGS
107 033204 ANALYSIS DATUM STATUS FLAGS
108 225000 DIFFERENCE STATISTICAL VALUES FOLLOW
109 237000 USE PREVIOUSLY DEFINED BIT MAP
110 001031 GENERATING CENTRE
111 008024 DIFFERENCE STATISTICS
112 225255 U-COMPONENT
113 225255 V-COMPONENT
114 225255 HEIGHT (HIGH ACCURACY)
115 225255 TEMPERATURE/DRY BULB TEMPERATURE
116 225000 DIFFERENCE STATISTICAL VALUES FOLLOW
117 237000 USE PREVIOUSLY DEFINED BIT MAP
118 001031 GENERATING CENTRE
119 008024 DIFFERENCE STATISTICS
120 225255 U-COMPONENT
121 225255 V-COMPONENT
122 225255 HEIGHT (HIGH ACCURACY)
123 225255 TEMPERATURE/DRY BULB TEMPERATURE
124 225000 DIFFERENCE STATISTICAL VALUES FOLLOW
125 237000 USE PREVIOUSLY DEFINED BIT MAP
126 001031 GENERATING CENTRE
127 008024 DIFFERENCE STATISTICS
128 225255 U-COMPONENT
129 225255 V-COMPONENT
130 225255 HEIGHT (HIGH ACCURACY)
131 225255 TEMPERATURE/DRY BULB TEMPERATURE

STARTING SUBSET TO BE PRINTED : 1
ENDING SUBSET TO BE PRINTED : 1

EXPANDED BUFR MESSAGE

BUFR MESSAGE DATA TYPE 4
RDB DATA SUBTYPE 142
TOTAL BUFR LENGTH (BYTES) 362

1 AIRCRAFT IDENTI 1008.0000 CCITTIA5 FIN147
2 AIRCRAFT NAVA 18 MISSING CODE TABLE 2061
3 YEAR 1994.0000 YEAR
4 MONTH 9.0000 MONTH
5 DAY 5.0000 DAY
6 HOUR 10.0000 HOUR
7 MINUTE 51.0000 MINUTE
8 LATITUDE (HIGH 79.0000 DEGREE
9 LONGITUDE (HIGH -60.0000 DEGREE
10 PHASE OF AIRCRA 1008.0000 M
11 HEIGHT OR ALTIT 10670.0000 M
12 TEMPERATURE/DRY 228.2000 K
13 WIND DIRECTION 195.0000 DEGREE TRUE
14 WIND SPEED 13.0000 W/S
15 DEGREE OF TURB 1008.0000 M
16 HEIGHT OF BASE 1008.0000 M
17 HEIGHT OF TOP O 1008.0000 M
18 AIRFRAME ICING 1008.0000 M
19 QUALITY INFORMA 1008.0000 M
20 DATA PRESENT IN 1008.0000 M
21 DATA PRESENT IN 1008.0000 M
22 DATA PRESENT IN 1008.0000 M
23 DATA PRESENT IN 1008.0000 M
24 DATA PRESENT IN 1008.0000 M
25 DATA PRESENT IN 1008.0000 M
26 DATA PRESENT IN 1008.0000 M
27 DATA PRESENT IN 1008.0000 M
28 DATA PRESENT IN 1008.0000 M
29 DATA PRESENT IN 1008.0000 M
30 DATA PRESENT IN 1008.0000 M
31 DATA PRESENT IN 1008.0000 M
32 DATA PRESENT IN 1008.0000 M
33 DATA PRESENT IN 1008.0000 M
34 DATA PRESENT IN 1008.0000 M
35 DATA PRESENT IN 1008.0000 M
36 DATA PRESENT IN 1008.0000 M
37 DATA PRESENT IN 1008.0000 M
38 GENERATING CENT 98.0000 CODE TABLE 1031
39 GENERATING APL 1.0000 CODE TABLE 1201
40 % CONFIDENCE 70.0000 NUMERIC
41 % CONFIDENCE 70.0000 NUMERIC
42 % CONFIDENCE 70.0000 NUMERIC
43 % CONFIDENCE 70.0000 NUMERIC
44 % CONFIDENCE 70.0000 NUMERIC
45 % CONFIDENCE 70.0000 NUMERIC
46 % CONFIDENCE 82.0000 NUMERIC
47 % CONFIDENCE 82.0000 NUMERIC
4.2 Examples

4.2.1 To unpack and print data

To pack and print data
This program is an interactive version for Bufr data handling. It decodes and encodes unpacked data as a single
or multi-subset Bufr messages. It calls BUBOX and BUPRTBOX routines to resolve the bit map.
The outputs of the expanded AIREP data using normal Bufr print routines and BUPRTBOX are attached.

```
PROGRAM BUFR
C
C**** *BUFR*
C
C
C PURPOSE.
C --------
C EXAMPLE OF USING BUFR UNPACKING/PACKING SOFTWARE.
C
C INTERFACE.
C *******
C NONE.
C
C METHOD.
C -------
C NONE.
C
C EXTERNALS.
C *******
C
C CALL BUSL
C CALL BUFREX
C CALL BUFREN
C CALL BUSS0
C CALL BUSS1
C CALL BUSS2
C CALL BUSS3
C CALL BUPT
C CALL BUKEY
C
C REFERENCE.
C ********
C NONE.
C
C AUTHOR.
C -------
C M. DRAGOSAVAC *ECMWF* 15/09/87.
C
C MODIFICATIONS.
C *********
C NONE.
C
C IMPLICIT LOGICAL(L,O,G), CHARACTER*8(C,H,Y)
C
PARAMETER(JSUP = 9,JSEC0= 3,JSEC1= 40,JSEC2= 64 ,JSEC3= 4,
1 JSEC4= 2,JELEM=80000,JSUBS=400,JVAL=150 , JBUFL=30000,
2 JBPW = 32,JTAB =3000,JCTAB=120,JCTST=1800,JCTEXT=1200,
3 JWORK=360000,JKEY=46, JBYTE=440000)
C
PARAMETER (KELEM=80000)
PARAMETER (KVALS=360000)
C
DIMENSION KBUFF(JBUFL)
DIMENSION KBUR(JBUFL)
DIMENSION KSUP(JSUP),KSEC0(JSEC0),KSSEC1(JSEC1)
DIMENSION KSSEC2(JSEC2),KSSEC3(JSEC3),KSSEC4(JSEC4)
DIMENSION KEY (JKEY),KRQ(2)
DIMENSION NREQUEST(2)
C
REAL(8) VALUES(KVALS),VALUE(KVALS)
DIMENSION KTDLST(JELEM),KTDEXP (JELEM),KRQ(KELEM)
REAL*8 RQV(KELEM)
DIMENSION KDTDATA(JELEM),KBOKR(JELEM*4)
```
REAL*8 VALS(KVALS)

REAL*8 VAL

CHARACTER*256 CF,COUT,CARG(4)

CHARACTER*64 CAMES(KELEM),CBOXN(JELEM*4)

CHARACTER*24 CUNITS(KELEM),CBOXU(JELEM*4)

CHARACTER*80 CVALS(KELEM)

CHARACTER*80 CVAL(KELM)

CHARACTER*80 YENC

REAL*8 RVIND

REAL*8 EPS

EXTERNAL GETARG

C

C ------------------------------------------------------------------
C* 1. INITIALIZE CONSTANTS AND VARIABLES.
C ---------------------------------------

100 CONTINUE

C

C MISSING VALUE INDICATOR
C

NBYTPW=JBPW/8

RVIND=1.7E38

NVIND=2147483647

IOBS=0

EPS=10.E-10

NPACK=0

N=0

OO=.FALSE.

C

C INPUT FILE NAME
C

C GET INPUT AND OUTPUT FILE NAME.

C

NARG=IARGC()

C

IF(NARG.lt.2) THEN

PRINT*,'USAGE -- bufr_decode -i infile ' 

STOP

END IF

C

DO 101 J=1,NARG

CALL GETARG(J,CARG(J))

101 CONTINUE

C

IF(CARG(1).NE.'-i'.OR.

1 CARG(2).EQ.' ') THEN

PRINT*,'USAGE -- bufr_decode -i infile ' 

STOP

END IF

C

DO 10 I=1,KELEM

RQV(I)=RVIND

KRQ(I)=NVIND

103 CONTINUE

C

C* 1.2 OPEN FILE CONTAINING BUFR DATA.
C -------------------------------

120 CONTINUE

C

IRET=0

CALL PBOPEN(IUNIT,CF(1:II),'R',IRET)

IF(IRET.EQ.-1) STOP 'OPEN FAILED'

IF(IRET.EQ.-2) STOP 'INVALID FILE NAME'

IF(IRET.EQ.-3) STOP 'INVALID OPEN MODE SPECIFIED'

C

C -----------------------------------------------------------------
C* 2. SET REQUEST FOR EXPANSION.
C --------------------------

200 CONTINUE

C

OQRT=.FALSE.

OENC=.FALSE.

WRITE(*,*)' DO YOU WANT TO PRINT( Y/N ) : '

READ *,Y

IF(Y.EQ.'Y'.OR.Y.EQ.'y') THEN

GO TO 210

END IF

203 CONTINUE

C

C* 2. SET REQUEST FOR EXPANSION.
C --------------------------

54 ECMWF Technical Notes
END IF
WRITE(*,'(A,$)') ' DO YOU WANT ENCODING( Y/N ) : ' READ(*,'(A)') YENC IF(YENC(1:1).EQ.'Y'.OR.YENC(1:1).EQ.'y') THEN OENC=.TRUE.
ELSE
WRITE(*,'(A,$)') ' NUMBER OF SUBSETS TO PACK : ' READ(*,'(BN,I4)') NCOM
OCOMP=.FALSE.
WRITE(*,'(A,$)') ' DO YOU WANT COMPRESSION( Y/N ) : ' READ(*,'(A)') YCOMP IF(YCOMP(1:1).EQ.'Y'.OR.YCOMP(1:1).EQ.'y') OCOMP=.TRUE.
END IF
WRITE(*,'(A,$)') ' RECORD NUMBER TO START FROM : ' READ(*,'(BN,I6)') NR C 201 CONTINUE C WRITE(*,'(A,$)') ' REQUESTED ELEMENT : ' READ(*,'(BN,I6)') IEL WRITE(*,'(A,$)') ' REQUESTED VALUE : ' READ(*,'(BN,F12.2)') VAL IF(IEL.EQ.0) THEN KRQL=J ELSE J=J+1 KRQ(J)=IEL RQV(J)=VAL IF(VAL.EQ.0.) RQV(J)=RVIND END IF GO TO 201 C WRITE(*,'(A,$)') ' REQUESTED FLAG 1 : ' READ(*,'(BN,I6)') KREQ(1) WRITE(*,'(A,$)') ' REQUESTED FLAG 2 : ' READ(*,'(BN,I6)') KREQ(2) WRITE(*,'(A,$)') ' DO YOU WANT TO PRINT SECTION 0-3( Y/N ) : ' READ(*,'(A,$)') YENC OSEC3=.FALSE.
IF(YENC(1:1).EQ.'Y'.OR.YENC(1:1).EQ.'y') OSEC3=.TRUE.
C* 2.1 SET REQUEST FOR PARTIAL EXPANSION.
C~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
C 300 CONTINUE C IERR=0 KBUFL=0 C IRET=0 CALL PBBUFR(IUNIT,KBUFF,JBYTE*4,KBUFL,IRET)
IF(IRET.EQ.-1) THEN IF(N.NE.0) GO TO 600 PRINT*, 'NUMBER OF SUBSETS ',IOBS PRINT*, 'NUMBER OF MESSAGES ',N STOP 'EOF'
END IF IF(IRET.EQ.-2) STOP 'FILE HANDLING PROBLEM'
IF(IRET.EQ.-3) STOP 'ARRAY TOO SMALL FOR PRODUCT'
N=N+1 PRINT*, '----------------------------------',N,' ',KBUFL C KBUFL=KBUFL/MBYTE*4+1 IF(N.LT.NR) GO TO 300 C~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
C 4. EXPAND BUFR MESSAGE.
C~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
C 400 CONTINUE C CALL BUSS012(KBUFL,KBUFF,KSEC,KSEC0,KSEC1,KSEC2,KERR)
IF(KERR.NE.0) THEN PRINT*, 'ERROR IN BUSS012: ',KERR PRINT*, ' BUFR MESSAGE NUMBER ',N, ' CORRUPTED.
KERR=0 GO TO 300
END IF
C
KEL=KVALS/KSUP(6)
if(KEL.GT.JELEM) KEL=JELEM
C
CALL BUFREX(KBUFL,KBUFF,KSUP,KSEC0,KSEC1,KSEC2,KSEC3,KSEC4,KEL,CNAMES,CUNITS,KVALS,VALUES,CVALS,IERR)
C
IF(IERR.NE.0) THEN
IF(IERR.EQ.39) GO TO 300
CALL EXIT(2)
END IF
C
I0BS=I0BS+KSEC3(3)
C
NPACK=NPACK+1
C
C* 4.1 PRINT CONTENT OF EXPANDED DATA.
C
CONTINUE
C
IF(.NOT.OPRT) GO TO 500
IF(.NOT.OSEC3) GO TO 450
C
C* 4.2 PRINT SECTION ZERO OF BUFR MESSAGE.
C
CONTINUE
C
CALL BUPRS0(KSEC0)
C
C* 4.3 PRINT SECTION ONE OF BUFR MESSAGE.
C
CONTINUE
C
CALL BUPRS1(KSEC1)
C
C* 4.4 PRINT SECTION TWO OF BUFR MESSAGE.
C
CONTINUE
C
CALL BUPRS2(KSUP,KEY)
C
C* 4.5 PRINT SECTION 3 OF BUFR MESSAGE.
C
CONTINUE
C
FIRST GET DATA DESCRIPTORS
C
KERR=0
CALL BUSEL(KTDLEN,KTDLST,KTDEXL,KTDEXP,KERR)
C IF(KERR.NE.0) CALL EXIT(2)
C
PRINT CONTENT
C
IF(OSEC3) THEN
CALL BUFRES3(KSEC3,KTDLEN,KTDLST,KTDEXL,KTDEXP,KEL,CNAMES)
END IF
C
C* 4.6 PRINT SECTION 4 (DATA).
C
CONTINUE
C
IN THE CASE OF MANY SUBSETS DEFINE RANGE OF SUBSETS
C
IF(.NOT.OO) THEN
WRITE(*,'(A,$)') ' STARTING SUBSET TO BE PRINTED : ' ,READ(*,'(BN,I4)') IST
WRITE(*,'(A,$)') ' ENDING SUBSET TO BE PRINTED : ' ,READ(*,'(BN,I4)') IEND
OO=.FALSE.
END IF
C
PRINT DATA
C
ICODE=0
C IF(KSEC1(6).EQ.11) THEN
C i=1
C |end=a+ksec3(3)
C iers=0
C CALL BUFRT(ICODE,i,IST,KEL,CNAMES,CUNITS,CVALS,KALVS,VALUES,KSUP,KSEC1,IERR)
C ELSE
C RESOLVE BIT MAPS
This is an example of the expanded AIREP data containing quality control information.

ECMWF

BUFR DECODING SOFTWARE VERSION - 6.1
07 JULY 2003.

Your path for bufr tables is:

/home/ma/emos/tables/bufr/000220/

BUFR TABLES TO BE LOADED B0000980601.D0000980601

BUFR SECTION 0

LENGTH OF SECTION 0 (BYTES)  5
TOTAL LENGTH OF BUFR MESSAGE (BYTES)  162
BUFR EDITION NUMBER  3

BUFR SECTION 1

LENGTH OF SECTION 1 (BYTES)  18
BUFR EDITION NUMBER  3
ORIGINATING SUB-CENTRE  0
ORIGINATING CENTRE  98
UPDATE SEQUENCE NUMBER  1
FLAG (PRESENCE OF SECTION 2)  128
BUFR MESSAGE TYPE  4
### BUFR MESSAGE SUBTYPE 142

**BUFR SECTION 2**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPORT DATA BASE KEY</td>
<td></td>
</tr>
<tr>
<td>RDB DATA TYPE</td>
<td>7</td>
</tr>
<tr>
<td>RDB DATA SUBTYPE</td>
<td>142</td>
</tr>
<tr>
<td>YEAR</td>
<td>2003</td>
</tr>
<tr>
<td>MONTH</td>
<td>7</td>
</tr>
<tr>
<td>DAY</td>
<td>15</td>
</tr>
<tr>
<td>HOUR</td>
<td>21</td>
</tr>
<tr>
<td>MINUTE</td>
<td>1</td>
</tr>
<tr>
<td>SECOND</td>
<td>34</td>
</tr>
<tr>
<td>LATITUDE</td>
<td>39.66</td>
</tr>
<tr>
<td>LONGITUDE</td>
<td>-86.38</td>
</tr>
<tr>
<td>IDENTIFIER</td>
<td>UAL1590</td>
</tr>
<tr>
<td>TOTAL BUFR MESSAGE LENGTH</td>
<td>162</td>
</tr>
<tr>
<td>DAY (RDB INSERTION)</td>
<td>15</td>
</tr>
<tr>
<td>HOUR (RDB INSERTION)</td>
<td>21</td>
</tr>
<tr>
<td>MINUTE (RDB INSERTION)</td>
<td>13</td>
</tr>
<tr>
<td>SECOND (RDB INSERTION)</td>
<td>46</td>
</tr>
<tr>
<td>DAY (MDB ARRIVAL)</td>
<td>15</td>
</tr>
<tr>
<td>HOUR (MDB ARRIVAL)</td>
<td>21</td>
</tr>
<tr>
<td>MINUTE (MDB ARRIVAL)</td>
<td>12</td>
</tr>
<tr>
<td>SECOND (MDB ARRIVAL)</td>
<td>57</td>
</tr>
<tr>
<td>CORRECTION NUMBER</td>
<td>0</td>
</tr>
<tr>
<td>PART OF MESSAGE</td>
<td>1</td>
</tr>
<tr>
<td>CORRECTION NUMBER</td>
<td>0</td>
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</tr>
<tr>
<td>PART OF MESSAGE</td>
<td>0</td>
</tr>
<tr>
<td>CORRECTION NUMBER</td>
<td>0</td>
</tr>
<tr>
<td>PART OF MESSAGE</td>
<td>0</td>
</tr>
<tr>
<td>QUALITY CONTROL &amp; CONF</td>
<td>70</td>
</tr>
</tbody>
</table>

### BUFR SECTION 3

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH OF SECTION 3 (BYTES)</td>
<td>24</td>
</tr>
<tr>
<td>RESERVED</td>
<td>0</td>
</tr>
<tr>
<td>NUMBER OF DATA SUBSETS</td>
<td>1</td>
</tr>
<tr>
<td>FLAG (DATA TYPE/DATA COMPRESSION)</td>
<td>128</td>
</tr>
</tbody>
</table>

**DATA DESCRIPTORS (UNEXPANDED)**

1. 311001
2. 222000
3. 101018
4. 031031
5. 001031
6. 001032
7. 101018
8. 033007

**DATA DESCRIPTORS (EXPANDED)**

1. 001006 AIRCRAFT FLIGHT NUMBER
2. 002061 AIRCRAFT NAVIGATIONAL SYSTEM
3. 004001 YEAR
4. 004002 MONTH
5. 004003 DAY
6. 004004 HOUR
7. 004005 MINUTE
8. 005001 LATITUDE (HIGH ACCURACY)
9. 006001 LONGITUDE (HIGH ACCURACY)
10. 008004 PHASE OF AIRCRAFT FLIGHT
11. 007002 HEIGHT OR ALTITUDE
12. 012001 TEMPERATURE/DRY BULB TEMPERATURE
4.2 Examples

13 011001 WIND DIRECTION
14 011002 WIND SPEED
15 011031 DEGREE OF TURBULENCE
16 011032 HEIGHT OF BASE OF TURBULENCE
17 011033 HEIGHT OF TOP OF TURBULENCE
18 020041 AIRFRAME ICING
19 222000 QUALITY INFORMATION FOLLOW
20 031031 DATA PRESENT INDICATOR
21 031031 DATA PRESENT INDICATOR
22 031031 DATA PRESENT INDICATOR
23 031031 DATA PRESENT INDICATOR
24 031031 DATA PRESENT INDICATOR
25 031031 DATA PRESENT INDICATOR
26 031031 DATA PRESENT INDICATOR
27 031031 DATA PRESENT INDICATOR
28 031031 DATA PRESENT INDICATOR
29 031031 DATA PRESENT INDICATOR
30 031031 DATA PRESENT INDICATOR
31 031031 DATA PRESENT INDICATOR
32 031031 DATA PRESENT INDICATOR
33 031031 DATA PRESENT INDICATOR
34 031031 DATA PRESENT INDICATOR
35 031031 DATA PRESENT INDICATOR
36 031031 DATA PRESENT INDICATOR
37 031031 DATA PRESENT INDICATOR
38 001031 IDENTIFICATION OF ORIGINATING/GENERATING CENTRE
39 001032 GENERATING APPLICATION
40 033007 % CONFIDENCE
41 033007 % CONFIDENCE
42 033007 % CONFIDENCE
43 033007 % CONFIDENCE
44 033007 % CONFIDENCE
45 033007 % CONFIDENCE
46 033007 % CONFIDENCE
47 033007 % CONFIDENCE
48 033007 % CONFIDENCE
49 033007 % CONFIDENCE
50 033007 % CONFIDENCE
51 033007 % CONFIDENCE
52 033007 % CONFIDENCE
53 033007 % CONFIDENCE
54 033007 % CONFIDENCE
55 033007 % CONFIDENCE
56 033007 % CONFIDENCE
57 033007 % CONFIDENCE
58 033007 % CONFIDENCE

STARTING SUBSET TO BE PRINTED : 1
ENDING SUBSET TO BE PRINTED : 1

1 AIRCRAFT FLIGHT .1008000000E+04 CCITTIA5 UAL1590
2 AIRCRAFT NAVIGATION CODE TABLE 2061
3 YEAR .2003000000E+04 YEAR
4 MONTH .7000000000E+01 MONTH
5 DAY .1500000000E+02 DAY
6 HOUR .2100000000E+02 HOUR
7 MINUTE .1000000000E+01 MINUTE
8 LATITUDE (HIGH) .3966000000E+02 DEGREE
9 LONGITUDE (HIGH) -.8638000000E+02 DEGREE
10 PHASE OF AIRCRAFT CODE TABLE 8004
11 HEIGHT OR ALTITUDE .1220000000E+04 M
12 TEMPERATURE/DRY .2922000000E+03 K
13 WIND DIRECTION .2930000000E+03 DEGREE TRUE
14 WIND SPEED .1400000000E+02 M/S
15 DEGREE OF TURBULENCE CODE TABLE 11031
16 HEIGHT OF BASE .1220000000E+04 M
17 HEIGHT OF TOP OF TURBULENCE .8638000000E+02 DEGREE
18 AIRFRAME ICING CODE TABLE 20041
19 QUALITY INFORMATION CODE TABLE 20041
20 DATA PRESENT IN .0000000000E+00 NUMERIC
21 DATA PRESENT IN .0000000000E+00 NUMERIC
22 DATA PRESENT IN .0000000000E+00 NUMERIC
23 DATA PRESENT IN .0000000000E+00 NUMERIC
24 DATA PRESENT IN .0000000000E+00 NUMERIC
25 DATA PRESENT IN .0000000000E+00 NUMERIC
26 DATA PRESENT IN .0000000000E+00 NUMERIC
27 DATA PRESENT IN .0000000000E+00 NUMERIC
28 DATA PRESENT IN .0000000000E+00 NUMERIC
29 DATA PRESENT IN .0000000000E+00 NUMERIC
30 DATA PRESENT IN .0000000000E+00 NUMERIC
31 DATA PRESENT IN .0000000000E+00 NUMERIC
32 DATA PRESENT IN .0000000000E+00 NUMERIC
33 DATA PRESENT IN .0000000000E+00 NUMERIC
34 DATA PRESENT IN .0000000000E+00 NUMERIC
35 DATA PRESENT IN .0000000000E+00 NUMERIC
36 DATA PRESENT IN .0000000000E+00 NUMERIC
37 DATA PRESENT IN .0000000000E+00 NUMERIC
38 IDENTIFICATION CODE TABLE 1031
39 GENERATING APPLICATION CODE TABLE 1032
40 % CONFIDENCE .7000000000E+02 NUMERIC
41 % CONFIDENCE .7000000000E+02 NUMERIC
42 % CONFIDENCE .7000000000E+02 NUMERIC
43 % CONFIDENCE .7000000000E+02 NUMERIC
44 % CONFIDENCE .7000000000E+02 NUMERIC
45 % CONFIDENCE .7000000000E+02 NUMERIC
46 % CONFIDENCE .7000000000E+02 NUMERIC
47 % CONFIDENCE .7000000000E+02 NUMERIC
48 % CONFIDENCE .7000000000E+02 NUMERIC
49 % CONFIDENCE .7000000000E+02 NUMERIC
50 % CONFIDENCE .7000000000E+02 NUMERIC
51 % CONFIDENCE .7000000000E+02 NUMERIC
52 % CONFIDENCE .7000000000E+02 NUMERIC
53 % CONFIDENCE .7000000000E+02 NUMERIC
54 % CONFIDENCE .7000000000E+02 NUMERIC
55 % CONFIDENCE .7000000000E+02 NUMERIC
56 % CONFIDENCE .7000000000E+02 NUMERIC
57 % CONFIDENCE .7000000000E+02 NUMERIC

ECMWF Technical Notes 59
Output of the AIREP data after calling BUBOX and BUPRTBOX routines

```
1 OPERATOR ************** 222000.0
2 GENERATING CENTRE( CODE TABLE 00 ************** 98.0
3 GENERATING APPLICATION (CODE TAB ************** 1.0
4 STATISTICS (008024/008023) ************** ********
5 INCREMENTAL UPDATE NUMBER ************** ********
6 MINIMISATION SIMULATION NUMBER ************** ********
7 AIRCRAFT FLIGHT NUMBER 1008.0 70.0
8 AIRCRAFT NAVIGATIONAL SYSTEM ************** 70.0
9 YEAR 2003.0 70.0
10 MONTH 7.0 70.0
11 DAY 15.0 70.0
12 HOUR 21.0 70.0
13 MINUTE 1.0 70.0
14 LATITUDE (HIGH ACCURACY) 39.7 70.0
15 LONGITUDE (HIGH ACCURACY) -86.4 70.0
16 PHASE OF AIRCRAFT FLIGHT ************** 70.0
17 HEIGHT OR ALTITUDE 1220.0 79.0
18 TEMPERATURE/DRY BULB TEMPERATURE 292.2 70.0
19 WIND DIRECTION 293.0 70.0
20 WIND SPEED 14.0 70.0
21 DEGREE OF TURBULENCE ************** 70.0
22 HEIGHT OF BASE OF TURBULENCE ************** 70.0
23 HEIGHT OF TOP OF TURBULENCE ************** 70.0
24 AIRFRAME ICING ************** 70.0
```

4.2.2 To expand data descriptors only

```
PROGRAM TDEXP
C
C**** *TDEXP*
C
C PURPOSE.
C --------
C Expands list of Bufr data descriptors.
C
C INTERFACE.
C -------------
C
C EXTERNALS.
C -------------
C
C REFERENCE.
C ----------
C
```

4.2 Examples

M. DRAGOSAVAC  "ECMWF"  15/06/93.

MODIFICATIONS.

IMPILIT LOGICAL(L,O,G), CHARACTER*8(C,H,Y)
PARAMETER(JSEC1=40,JSEC3=4)
PARAMETER (KDLEN=20,KELEM=2700,KVALS=2700)
DIMENSION KSEC1(JSEC1)  ! ,KSEC3(JSEC3)
DIMENSION KTDLST(KELEM),KTDEXP(KELEM)
DIMENSION KDATA(KDLEN)
CHARACTER*64 CNAMES(KELEM)
CHARACTER*24 CUNITS(KELEM)
DATA CNAMES/KELEM*' '/,CUNITS/KELEM*' '/

1. INITIALIZE CONSTANTS AND VARIABLES.

CONTINUE

Missing value indicator
RVIND=1.7E38

INITIALIZE DELAYED REPLICATION FACTORS OR REFERENCE VALUES ETC.
KDATA(1)=2
KDATA(2)=14
KDATA(3)=2
KDATA(4)=2

SET DATA DESCRIPTORS
KTDLST( 1)=301001
KTDLST( 2)=301011
KTDLST( 3)=301012
KTDLST( 4)=301021
KTDLST( 5)=707000
KTDLST( 6)=6031001
KTDLST( 7)=607004
KTDLST( 8)=8088001
KTDLST( 9)=9010003
KTDLST(10)=1012001
KTDLST(11)=0121003
KTDLST(12)=0011003
KTDLST(13)=011004
KTDLST(14)=224000
KTDLST(15)=236000
KTDLST(16)=6010000
KTDLST(17)=031001
KTDLST(18)=031031
KTDLST(19)=001031
KTDLST(20)=001032
KTDLST(21)=008023
KTDLST(22)=105000
KTDLST(23)=031001
KTDLST(24)=204002
KTDLST(25)=031021
KTDLST(26)=204002
KTDLST(27)=301021
KTDLST(28)=224255
KTDLST(29)=604000
KTDLST(30)=025000
KTDLST(31)=307000
KTDLST(32)=001031
KTDLST(33)=001032
KTDLST(34)=008024
KTDLST(35)=101000
KTDLST(36)=031001
KTDLST(37)=225255

KTDLST=37

SECTION 1 CONTENT
KSEC1(2)=2  ! BUFR EDITION NUMBER
KSEC1(3)=98  ! ORIGINATING CENTRE
KSEC1(8)=1  ! VERSION NUMBER OF LOCAL TABLE USED
KSEC1(15)=2  ! VERSION NUMBER OF MASTER TABLE USED

SECTION 3 CONTENT
The output of the expanded data using BUXDES routine is given below.

```plaintext
BUFR ENCODING SOFTWARE VERSION - 2.0

Your path for Bufr tables is:
/home/ecmwf/emos_sms/tables/BUFR/test/
BUFR Tables to be loaded B000980201,C000980201,D000980201

Data descriptors (unexpanded)

1 301001
2 301011
3 301012
4 301011
5 107000
6 031001
7 007004
8 008001
9 010003
10 012001
11 012003
12 011003
13 011004
14 224000
15 236000
16 101000
17 031001
18 031031
19 001031
20 001032
21 008023
22 105000
23 031001
24 204002
25 031021
26 204002
27 031021
28 224255
29 204000
30 225000
31 237000
32 001031
33 001032
34 008024
35 101000
36 031001
37 225255

Data descriptors (expanded)

<table>
<thead>
<tr>
<th>Element name</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 001001</td>
<td>WMO BLOCK NUMBER</td>
</tr>
<tr>
<td>2 001002</td>
<td>WMO STATION NUMBER</td>
</tr>
<tr>
<td>3 004001</td>
<td>YEAR</td>
</tr>
<tr>
<td>4 004002</td>
<td>MONTH</td>
</tr>
<tr>
<td>5 004003</td>
<td>DAY</td>
</tr>
<tr>
<td>6 004004</td>
<td>HOUR</td>
</tr>
<tr>
<td>7 004005</td>
<td>MINUTE</td>
</tr>
<tr>
<td>8 005001</td>
<td>LATITUDE (HIGH ACCURACY)</td>
</tr>
<tr>
<td>9 006001</td>
<td>LONGITUDE (HIGH ACCURACY)</td>
</tr>
<tr>
<td>10 031001</td>
<td>DELAYED DESCRIPTOR REPETITION FACTOR</td>
</tr>
<tr>
<td>11 007004</td>
<td>PRESSURE</td>
</tr>
<tr>
<td>12 008001</td>
<td>VERTICAL SOUNDING SIGNIFICANCE</td>
</tr>
</tbody>
</table>
```
4.2 Examples

13 010003 GEOPOTENTIAL \(M^2/S^2\)
14 012001 TEMPERATURE/DRY BULB TEMPERATURE K
15 012003 DEM POINT TEMPERATURE K
16 011003 U-COMPONENT M/S
17 011004 V-COMPONENT M/S
18 007004 PRESSURE PA
19 008001 VERTICAL SOUNDING SIGNIFICANCE FLAG TABLE 8001
20 010003 GEOPOTENTIAL \(M^2/S^2\)
21 012001 TEMPERATURE/DRY BULB TEMPERATURE K
22 012003 DEM POINT TEMPERATURE K
23 011003 U-COMPONENT M/S
24 011004 V-COMPONENT M/S
25 224000 FIRST ORDER STATISTICS FOLLOW
26 236000 BACKWARD REFERENCE BIT MAP
27 031001 DELAYED DESCRIPTOR REPLICATION FACTOR NUMERIC
28 031031 DATA PRESENT INDICATOR NUMERIC
29 031031 DATA PRESENT INDICATOR NUMERIC
30 031031 DATA PRESENT INDICATOR NUMERIC
31 031031 DATA PRESENT INDICATOR NUMERIC
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39 031031 DATA PRESENT INDICATOR NUMERIC
40 031031 DATA PRESENT INDICATOR NUMERIC
41 031031 DATA PRESENT INDICATOR NUMERIC
42 001031 GENERATING CENTRE CODE TABLE 1031
43 224255 FIRST ORDER STATISTICS VALUE MARKER
44 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
45 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
46 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
47 000000 ASSOCIATED FIELD
48 225255 DIFFERENCE STATISTICS VALUE MARKER
49 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
50 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
51 031021 ASSOCIATED FIELD SIGNIFICANCE CODE TABLE 31021
52 000000 ASSOCIATED FIELD
53 224255 FIRST ORDER STATISTICS VALUE MARKER
54 225000 DIFFERENCE STATISTICAL VALUES FOLLOW
55 001031 GENERATING CENTRE CODE TABLE 1031
56 237000 USE PREVIOUSLY DEFINED BIT MAP
57 001031 GENERATING CENTRE CODE TABLE 1031
58 008024 DIFFERENCE STATISTICS CODE TABLE 8024
59 031001 DELAYED DESCRIPTOR REPLICATION FACTOR NUMERIC
60 225255 DIFFERENCE STATISTICS VALUE MARKER
61 225255 DIFFERENCE STATISTICS VALUE MARKER