WMO CODE FORM CHANGES

(Submitted by WMO)

Summary and purpose of document

To inform CGMS Members on the status of WMO Code Forms.

ACTIONS PROPOSED

CGMS to note the report and discuss as appropriate. CGMS Rapporteur of Codes to coordinate with the WMO Space Programme for submission of appropriate updated material.

Annexes: I.   Manual on Codes
II   Binary Codes
III   Common features

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1. Information Systems and Services (ISS), including the development of FWIS _Data Representation and Codes

1.1   The thirteenth session of CBS held in February 2005 in St Petersburg, Russian Federation (CBS-XIII) agreed to the following modifications to the Manual on Codes. CGMS Members should take into consideration the modifications within their activities for using WMO Data Representation and Codes.

1.2   CGMS should also note that Action 32.17 stated:

"A working group of CGMS Members should be established to draft a master BUFR table for satellite data. CGMS should designate a rapporteur between this group and the CBS ET on Data Representation and Codes. CGMS Member designated experts will be asked for input and to submit updates at upcoming CGMS meetings.   The WMO Space Programme will compile the input and maintain the master BUFR table for satellite data."

1.3   Thus the CGMS Rapporteur should coordinate with the WMO Space Programme for submission of appropriate updated material.

FM 92 GRIB Edition 2

1.4   Based on the results of tests and experimental exchanges, additional templates for two new compression schemes based on JPEG 2000 and PNG, as well as new parameters for image-type products and earth surface information, were recommended for operational use. However, more testing and validation were requested for the Weather-Huffman compression. (See Annex 1). Regarding the available GRIB 2 encoder/decoder software, the Commission took note with appreciation of the work done by ECMWF, EUMETSAT, DWD, JMA, NCEP and UKMO, and thanked those making their software freely available, especially the decoder, which would facilitate a wide use of GRIB 2 products.

FM 94 BUFR and FM 95 CREX tables

1.5   In the light of various requirements, and after validation and pre-operational use, corrections and additions to BUFR or CREX regulations and Tables were recommended for operational use (see Annex 2) A regulation was amended to clearly define displacement and increment descriptors. Encoding of Meteosat 8 data and Satellite Radio Occultation data was facilitated through appropriate table entries. Tables were adopted for operational use for the following data: AIRS satellite data, ENVISAT data, wave–spectra,.

New editions of FM 94 BUFR and FM 95 CREX

1.6   The Commission recommended additions for a new BUFR edition, which had been validated for representation of probabilities, forecast values and new operators. The other additions included in the new edition were the definition of international sub-categories, which would help the migration process (for sorting out bulletins), (See Annex 3). To increase the compatibility with BUFR, additions for a new edition of CREX were also recommended. The Commission recommended the new editions for operational implementation on 2 November 2005, with the understanding that both editions, for BUFR, editions 3 and 4, and for CREX editions 1 and 2, could be used in parallel up to 2012, when the migration process will be fully completed for most of the data types; then BUFR edition 4 and CREX edition 2 would be the only ones in use after that date. The Commission consequently urged BUFR and CREX decoder software providers to adjust their software as soon as possible to be able to decode BUFR edition 4 and CREX edition 2 as from 2 November 2005. Producers were also invited to encode data in the new editions formats as soon as possible.

1.7   The CBS-13 recommended operational implementation of the amendments on 2 November 2005.

2.   Information on the transition from GOES-9 AMVs to MTSAT-1R AMVs

2.1   The new Japanese geostationary meteorological satellite - Multi-functional Transport Satellite (MTSAT-1R) has been operational since 03 UTC on 28 June 2005.

2.2   Japan's Meteorological Satellite Center (MSC) has prepared for the transition of the production of cloud track winds from GOES-9 AMVs to MTSAT-1R AMVs.   The transition is anticipated to occur in the middle of July 2005. MSC will send out information by email as soon as the transition is made. GOES-9 AMVs products have been disseminated until that that time.

2.3   For the present time the bulletins WMO headers will stay the same.

2.4   The changes in the bulletins after the transition are as follows:

   (1)   Satellite identifier (WMO BUFR code table 0 01 007; 253(GOES-9) $\Rightarrow$ 171(MTSAT-1R))
   (2)   Satellite classification (WMO BUFR code table 0 02 020; 241(GOES) $\Rightarrow$ 272(MTSAT))
   (3)   Satellite channel centre frequency (WMO BUFR table B descriptor 0 02 153
   (4)   Satellite channel band width (WMO BUFR table B descriptor 0 02 154)

ADDITIONS TO FM 92-XII Ext. GRIB

Additional note at end of PDT 4.7:

Note: "This template should not be used. Production Definition Template 4.0 should be used instead."

For JPEG 2000:

The following Templates and Code tables are proposed for use with the JPEG 2000 image encoding.

Data Representation Template 5.40: Grid point data - JPEG 2000 Code Stream Format	
Octet Number(s)	Contents
12-15	Reference value (R) (IEEE 32-bit floating-point value)
16-17	Binary scale factor (E)
18-19	Decimal scale factor (D)
20	Number of bits required to hold the resulting scaled and referenced data values. (i.e. The depth of the grayscale image.) (see Note 2)
21	Type of original field values (see Code Table 5.1)
22	Type of Compression used. (see Code Table 5.40)
23	Target compression ratio, M:1 (with respect to the bit-depth specified in octet 20), when octet 22 indicates Lossy Compression. Otherwise, set to missing. (see Note 3)

Notes:

(1) The intent of this template is to scale the grid point data to obtain desired precision, if appropriate, and then subtract out reference value from the scaled field as is done using Data Representation Template 5.0. After this, the resulting grid point field can be treated as a grayscale image and is then encoded into the JPEG 2000 code stream format. To unpack the data field, the JPEG 2000 code stream is decoded back into an image, and the original field is obtained from the image data as described in regulation 92.9.4, Note (4).

(2) The JPEG 2000 standard specifies that the bit-depth must be in the range of 1 to 38 bits.

(3) The compression ratio M:1 (e.g. 20:1) specifies that the encoded stream should be less than $((1/M) \times depth \times number\_of\_data$ points) bits, where depth is specified in octet 20 and number_of_data points is specified in octets 6-9 of the Data Representation Section.

(4) The order of the data points should remain as specified in the scanning mode flags (Flag Table 3.4) set in the appropriate Grid Definition Template, even though the JPEG 2000 standard specifies that an image is stored starting at the top left corner. Assuming that the encoding software is expecting the image data in raster order (left to right across rows for each row), users should set the image width to Ni (or Nx) and the height to Nj (or Ny) if bit 3 of the scanning mode flag equals 0 (adjacent points in i (x) order), when encoding the "image". If bit 3 of the scanning mode flags equals 1 (adjacent points in j (y) order), it may be advantageous to set the image width to Nj (or Ny) and the height to Ni (or Nx).

(5) When the data points are not available on a rectangular grid, such as a would occur if some data points are bit-mapped out or if section 3 describes a quasi-regular grid, the data field can be treated as a one dimensional image where the height is set to 1 and the width is set to the total number of data points specified in octets 6-9.

Data Template 7.40: Grid point data - JPEG 2000 Code Stream Format	
Octet Number(s)	Contents
6-nn	JPEG 2000 Code Stream as described in Part1 of the JPEG 2000 standard. (ISO/IEC 15444-1:2000)
Note: For simplicity, image data should be packed specifying a single component (i.e. grayscale image) instead of a multi-component color image.	

Code Table 5.40: Type of Compression	
Code Figure	Meaning
0	Lossless
1	Lossy
2-254	Reserved
255	Missing

For Portable Network Graphics (PNG)

The following Templates are proposed for use with PNG image encoding.

Data Representation Template 5.41: Grid point data - Portable Network Graphics (PNG) Format	
Octet Number(s)	Contents
12-15	Reference value (R) (IEEE 32-bit floating-point value)
16-17	Binary scale factor (E)
18-19	Decimal scale factor (D)
20	Number of bits required to hold the resulting scaled and referenced data values. (i.e. The depth of the image.) (see Note 2)
21	Type of original field values (see Code Table 5.1)

Notes:

(1) The intent of this template is to scale the grid point data to obtain desired precision, if appropriate, and then subtract out reference value from the scaled field as is done using Data Representation Template 5.0. After this, the resulting grid point field can be treated as an image and is then encoded into PNG format. To unpack the data field, the PNG stream is decoded back into an image, and the original field is obtained from the image data as described in regulation 92.9.4, Note (4).

(2) PNG does not support all bit-depths in an image, so it is necessary to define which depths can be used and how they are to be treated. For grayscale images, PNG supports depths of 1, 2, 4, 8 or 16 bits. Red-Green-Blue (RGB) colour images can have depths of 8 or 16 bits with an optional alpha sample. Valid values for octet 20 can be:

1, 2, 4, 8, or 16 - treat as grayscale image

24 - treat as RGB colour image (each component having 8 bit depth)

32 - treat as RGB w/ alpha sample colour image (each component having 8 bit depth)

(3) The order of the data points should remain as specified in the scanning mode flags (Flag

Table 3.4) set in the appropriate Grid Definition Template, even though the PNG standard specifies that an image is stored starting at the top left corner and scans across each row from left to right starting with the top row. Users should set the image width to Ni (or Nx) and the height to Nj (or Ny) if bit 3 of the scanning mode flag equals 0 (adjacent points in i (x) order), when encoding the "image". If bit 3 of the scanning mode flags equals 1 (adjacent points in j (y) order), it may be advantageous to set the image width to Nj (or Ny) and the height to Ni (or Nx).

(4) When the data points are not available on a rectangular grid, such as a would occur if some data points are bit-mapped out or if section 3 describes a quasi-regular grid, the data field can be treated as a one dimensional image where the height is set to 1 and the width is set to the total number of data points specified in octets 6-9.

Data Template 7.41: Grid point data - Portable Network Graphics (PNG) Format

Octet Number(s)	Contents
6-nn	PNG encoded image

Note: If octet 20 of Data Representation Template 5.41 specifies the data is packed into either 1, 2, 4, 8, or 16 bits, then encode the "image" as a grayscale image. If octet 20 specifies 24 bits, encode the "image" as an Red-Green-Blue (RGB) colour image with 8 bit depth for each colour component, and finally if octet 20 is 32, encode the "image" as a RGB colour image with an alpha sample using an 8 bit depth for each of the four components.

Cloud analysis image of METEOSAT 8:
Addition to Code table 4.2:

Code Table 4.2, Product Discipline 3 – Space products, Parameter category 0: image format products

Add: Number 8, Parameter = Pixel scene type, Units = Code table (4.218)
Change: Number 8 – 191, Parameter = Reserved
to
Number 9 – 191, Parameter = Reserved

Add a new Code Table, 4.218:

Code Table 4.218 - Pixel scene type

0 = Nominal cloud top height quality
1 = Green needle leafed forest
2 = Green broad leafed forest
3 = Deciduous needle leafed forest
4 = Deciduous broad leafed forest
5 = Deciduous mixed forest
6 = Closed shrub-land
7 = Open shrub-land
8 = Woody savannah
9 = Savannah
10 = Grassland
11 = Permanent wetland
12 = Cropland
13 = Urban
14 = Vegetation / crops
15 = Permanent snow / ice

16 = Barren desert
17 = Water bodies
18 = Tundra
19-96 = Reserved
97 = Snow / ice on land
98 = Snow / ice on water
99 = Sun-glint
100= General cloud
101 = Low cloud / fog / Stratus
102 = Low cloud / Stratocumulus
103 = Low cloud / unknown type
104 = Medium cloud / Nimbostratus
105 = Medium cloud / Altostratus
106 = Medium cloud / unknown type
107 = High cloud / Cumulus
108 = High cloud / Cirrus
109 = High cloud / unknown
110 = Unknown cloud type
111-191 = Reserved
192-254 = Reserved for local use
255 = Missing

Multi-sensor precipitation estimate (EUMETSAT product):

Addition to Code table 4.2:

Code Table 4.2, Product Discipline 3 – Space products, Parameter category 1: quantitative products

Add:	Number 1, Parameter = Instantaneous rain rate, Units = kgm^2s^{-1}
Change: to	Number 1 – 191, Parameter = Reserved
	Number 2 – 191, Parameter = Reserved

METEOSAT 8 cloud top height:

Additions to Code table 4.2:

Code Table 4.2, Product Discipline 3 – Space products, Parameter category 1: quantitative products

Add:	Number 2, Parameter = Cloud top height, Units = m
Add:	Number 3, Parameter = Cloud top height quality indicator, Units = Code table (4.219)
Change: to	Number 1 – 191, Parameter = Reserved
	Number 4 – 191, Parameter = Reserved

Add a new Code Table, 4.219:

Code Table 4.219 - Cloud top height quality indicator

0 = No scene identified
1 = Fog in segment
2 = Poor quality height estimation
3 = Fog in segment and poor quality height estimation
4-191 = Reserved
192-254 = Reserved for local use

255 = Missing

- Add the following note at end of DRTs 5.0 and 5.50:

Note: "Negative values of E or D shall be represented according to Regulation 92.1.5."

Clarification for the unit for the Earth radius:

*Add the following note to the relevant GDTs * as the last one:*

Note:
*(x) ** A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth is derived from applying appropriate scale factor to the value expressed in metres.*

*   GDTs 3.0, 3.10, 3.20, 3.30, 3.31, 3.40, 3.90, 3.110, 3.1000 and 3.1100
**   x depends on the number of Notes to the corresponding GDT.

*Modify **Code Table 3.2 – Shape of the Earth as follows:***

0   *(unchanged)*
1   Earth assumed spherical with radius (in m) specified by data producer
2   *(unchanged)*
3   Earth assumed oblate spheroid with major and minor axes specified (in km) by data
          producer
4   *(unchanged)*
5   *(unchanged)*
6   *(unchanged)*
7   Earth assumed oblate spheroid with major and minor axes specified (in m) by data
          producer
8-191   Reserved
192-254   Reserved for local use
255 Missing

Add new Code table:

Code table 4.222 – Categorical result
Code figure   Meaning
   0   No
   1   Yes
  2-191   Reserved
 192-254   Reserved for local use
   255 Missing

ADDITIONS TO FM 94-XII Ext. BUFR AND FM 95-XII Ext. CREX

Amend existing FM 94 BUFR regulation 94.5.3.8 and CREX regulation 95.3.5.5 as follows:

1   Increments:

      Any occurrence of an element descriptor from classes 04 to 07, which defines an increment, shall indicate that the location corresponding to that class be incremented by the corresponding data value. In the case of successive increments from the same class, this means that each increment applies in a cumulative manner, with all preceding increments remaining in effect.

      Displacements:

      In contrast, any displacement descriptor from classes 04 to 07 does not redefine the location corresponding to that class. In the case of successive displacements from the same class, this means that each displacement applies independently and in a non-cumulative manner to the location corresponding to that class.

DESCRIPTORS FOR AIRS SATELLITE DATA

In BUFR Table B:

```
Log-10 of principal components normalized fit to data
0-25-052          Numeric     4     0      15
```

In BUFR Table D:

```
--------------------------------------------------------------
3-10-050    Satellite collocated 1C reports with 3 instruments
--------------------------------------------------------------
     3-10-051    Satellite position and instrument temperatures
     3-10-052    Satellite instrument type and position (AIRS)
     1-01-000    Delayed replication of 1 descriptor
     0-31-002    Extended delayed descriptor replication factor
     3-10-053    Satellite channels and brightness temperatures with expanded
                 channel set (AIRS)
     1-01-004    Replicate 1 descriptor 4 times
     3-10-054    Satellite visible channels and albedos with expanded channel
                 set
     0-20-010    Cloud cover (total)
     3-10-052    Satellite instrument type and position (AMSU-A)
     1-01-015    Replicate 1 descriptor 15 times
     3-10-053    Satellite channels and brightness temperatures with expanded
                 channel set (AMSU-A)
     3-10-052    Satellite instrument type and position (HSB)
     1-01-005    Replicate 1 descriptor 5 times
     3-10-053    Satellite channels and brightness temperatures with expanded
                 channel set (HSB)


--------------------------------------------------------------
3-10-051    Satellite position and instrument temperatures
--------------------------------------------------------------

     0-01-007    Satellite identifier
     0-05-040    Orbit number
     2-01-133    Change data width
     0-05-041    Scan line number
     2-01-000    Cancel change data width
```

```
        2-01-132    Change data width
        0-25-070    Major frame count
        2-01-000    Cancel change data width
        2-02-126    Change scale
        0-07-001    Height of station
        2-02-000    Cancel change scale
        0-07-025    Solar zenith angle
        0-05-022    Solar azimuth
        1-02-009    Replicate 2 descriptors 9 times
        0-02-151    Radiometer identifier
        0-12-064    Instrument temperature


----------------------------------------------------
3-10-052    Satellite instrument type and position
----------------------------------------------------


        0-02-019    Satellite instruments
        3-01-011    Year, month, day
        3-01-012    Hour, minute
        2-02-131    Change scale
        2-01-138    Change data width
        0-04-006    Second
        2-01-000    Cancel change data width
        2-02-000    Cancel change scale
        3-01-021    Latitude and longitude (high accuracy)
        0-07-024    Satellite zenith angle
        0-05-021    Bearing or azimuth
        0-05-043    Field of view number


------------------------------------------------------------------------------
3-10-053    Satellite channels and brightness temperatures with expanded channel
            set
------------------------------------------------------------------------------

        2-01-134    Change data width
        0-05-042    Channel number
        2-01-000    Cancel change data width
        0-25-076    Log-10 of temperature-radiance central wave number for ATOVS
        0-33-032    Channel quality flags for ATOVS
        0-12-163    Brightness temperature (scale 2)


------------------------------------------------------------------------------
3-10-054    Satellite visible channels and albedos with expanded channel set
------------------------------------------------------------------------------

        2-01-134    Change data width
        0-05-042    Channel number
        2-01-000    Cancel change data width
        0-25-076    Log-10 of temperature-radiance central wave number for ATOVS
        0-33-032    Channel quality flags for ATOVS
        2-01-131    Change data width
        2-02-129    Change scale
        1-02-002    Replicate 2 descriptors 2 times
        0-08-023    First-order statistics
        0-14-027    Albedo
        0-08-023    First-order statistics
        2-02-000    Cancel change scale
        2-01-000    Cancel change data width
```

```
-----------------------------------------------------------
3-10-055    Satellite radiance/channel principle components
-----------------------------------------------------------

        3-10-051    Satellite position and instrument temperatures
        3-10-052    Satellite instrument type and position (AIRS)
        1-02-020    Replicate 2 descriptors 20 times
        0-25-076    Log-10 of temperature-radiance central wave number for ATOVS
        0-25-052    Log-10 of principal components normalized fit to data
        1-01-000    Delayed replication of 1 descriptor
        0-31-002    Extended delayed descriptor replication factor
        0-25-050    Principal components of satellite radiance
```

Additions for METEOSAT 8 data

Name	Units	Range	Precision	Proposed descriptor	Reference value	Scale	Width (bits)
Number of observations	Numeric	0 – 99	± 1	0-08-049	0	0	8
Cloud index	Code table	0 – 99	± 1	0-20-050	0	0	8
Cloud phase	Code table	0 - 3	± 1	0-20-056	0	0	3

Code table (0-20-050) cloud index

    0 = reserved
    1 = 1st low cloud
    2 = 2nd low cloud
    3 = 3rd low cloud
    4 = 1st medium cloud
    5 = 2nd medium cloud
    6 = 3rd medium cloud
    7 = 1st high cloud
    8 = 2nd high cloud
    9 – 254 = reserved
    255 = missing

Code table (0-20-056) cloud phase

    0 = unknown
    1 = water
    2 = ice
    3 = mixed
    4 – 6 = reserved
    7 = missing

Climate data set products from METEOSAT

Climate data set products from the earlier METEOSAT satellites have been and continue to be produced, and are archived at EUMETSAT, both in an internal format and in BUFR. In order to encode all of the required parameters, the following addition descriptors are proposed:

Name	Units	Range	Precision	Proposed descriptor	Reference value	Scale	Width (bits)
Amount of segment covered by scene	%	0 – 100	± 1	0-20-083	0	0	7
Sun-glint indicator	Code table	0 – 1	± 1	0-08-065	0	0	2
Semi-transparency indicator	Code table	0 - 1	± 1	0-08-066	0	0	2
Sun to satellite azimuth difference	Degrees	-180 – 180	± 0.1	0-05-023	-1800	1	12

Code table (0-08-065) sun-glint indicator

    0 = no sun-glint
    1 = sun-glint
    2 = reserved
    3 = missing

Code table (0-08-066) semi-transparency indicator

    0 = opaque
    1 = semi-transparent
    2 = reserved
    3 = missing

Global instability index

Name	Units	Range	Precision	Proposed descriptor	Reference value	Scale	Width (bits)
K Index	Kelvin	-20 – 50	± 1	0-13-044	-30	0	8
KO Index	Kelvin	-20 – 20	± 1	0-13-045	-30	0	8
Maximum buoyancy	Kelvin	-20 – 40	± 1	0-13-046	-30	0	8

Clear sky radiance
The additional features of the classification scheme used for METEOSAT 8 mean that it is possible to derive a new type of confidence measure for the clear sky radiance data. Additionally, a quality control mechanism based on the "Gaussian-ness" of the distribution of the clear sky radiance values is also being finalized. In order to encode confidence values from both of these schemes, two additional code table entries, 3 and 4, are proposed in Code table 0 08 033.

The "method of derivation of percentage confidence" code table (0-08-033) would be as follows:

    0 = reserved
    1 = percentage confidence calculated using cloud fraction
    2 = percentage confidence calculated using standard deviation of temperature
    3 = percentage confidence calculated using probability of cloud contamination
    4 = percentage confidence calculated using normality of distribution
    5 – 126 = reserved
    127 = missing

Add one entry in Code table (0-02-163) - height assignment method

    14 = Composite height assignment

ADDITIONS FOR ENVISAT DATA

a) *AATSR - **A**dvanced **A**long **T**rack **S**canning **R**adiometer is the advanced version of the ATSR system operated on ERS1 and ERS2. The main objective of the AATSR is precise measurement of sea surface temperature (SST).*

Proposal for standard WMO BUFR Table B entries:
```
-------------------------------------------------

001096 STATION ACQUISITION      CCITTIA5        0         0  160
002174 MEAN ACROSS TRACK PIXEL  NUMERIC         0         0    9
       NUMBER
012180 AVERAGED 12 MICRON BT FOR K             2         0   16
       ALL CLEAR PIXELS AT NADIR
012181 AVERAGED 11 MICRON BT FOR K             2         0   16
       ALL CLEAR PIXELS AT NADIR
012182 AVERAGED 3.7 MICRON BT    K             2         0   16
       FOR ALL CLEAR PIXELS AT
       NADIR
012183 AVERAGED 12 MICRON BT FOR K             2         0   16
       ALL CLEAR PIXELS, FORWARD
       VIEW
012184 AVERAGED 11 MICRON BT     K             2         0   16
       FOR ALL CLEAR PIXELS,
       FORWARD VIEW
012185 AVERAGED 3.7 MICRON BT    K             2         0   16
       FOR ALL CLEAR PIXELS,
       FORWARD VIEW
012186 MEAN NADIR SEA SURFACE    K             2         0   16
       TEMPERATURE
012187 MEAN DUAL VIEW SEA        K             2         0   16
       SURFACE TEMPERATURE
021086 NUMBER OF PIXELS IN NADIR NUMERIC        0         0    9
       ONLY, AVERAGE
021087 NUMBER OF PIXELS IN DUAL  NUMERIC        0         0    9
       VIEW, AVERAGE
033043 AST CONFIDENCE           FLAG TABLE      0         0    8
```

033043 FLAG TABLE AST CONFIDENCE

```
 Bit No.            Meaning

   1                SEA MDS. NADIR ONLY SST RETRIEVAL USED 3.7
                    MICRON CHANNEL. LAND MDS RESERVED
   2                SEA MDS. DUAL VIEW SST RETRIEVAL USED 3.7 MICRON
```

```
                    CHANNEL. LAND MDS RESERVED
  3                 NADIR VIEW CONTAINS DAY TIME DATA
  4                 FORWARD VIEW CONTAINS DAY TIME DATA
  5-7               RESERVED
  All               MISSING VALUE
```

Proposal for standard WMO BUFR Table D entries：
```
 ----------------------------------------------

 312045     - AATSR sea surface temperatures

 312045     001007 Satellite identifier
            002019 Satellite instruments
            001096 Station acquisition
            025061 Software identification and version number
            005040 Orbit number
            301011 Date
            301013 Time
            301021 Lat/long
            007002 Height or altitude
            012180 Average 12 micron BT for all clear pixels at nadir
            012181 Average 11 micron BT for all clear pixels at nadir
            012182 Average 3.7 micron BT for all clear pixels at nadir
            012183 Average 12 micron BT for all clear pixels, forward view
            012184 Average 11 micron BT for all clear pixels, forward view
            012185 Average 3.7 micron BT for all clear pixels, forward view
            002174 Mean across track pixel number
            021086 Number of pixels in nadir only, average
            012186 Mean nadir sea surface temperature
            021087 Number of pixels in dual view, average
            012187 Mean dual view sea surface temperature
            033043 ATS confidence
```

*b) **SCIAMACHY-** The Scanning Imaging Absorption Spectrometer for Atmospheric Cartography. The instrument provides spectra measured from light transmitted, back scattered or reflected by trace gases in the atmosphere and needs existing standard entry 310020.*

*c) **MIPAS -** The Michelson Interferometer for Passive Atmospheric Sounding. The instrument measures atmospheric radiation emitted by trace gases in the infrared spectral range 4.14 to 14.6 micro meters.*

BUFR Table B reserved entry:

```
013098 INTEGRATED WATER VAPOUR KG/M**2       8        0        30
       DENSITY
```

BUFR table D reserved entry:

```
310030     310022 Satellite id, product type
           301011 Date
           301013 Time
           301021 Lat/long
           304034 Lat/long, solar elevation, number of layers
           310029 Layer, ozone, height, temperature and water vapour
```

```
310029      110000
            031001 Delayed replication
            201138 Change data width
            202130 Change scale
            007004 Pressure
            007004 Pressure
            202000 Cancel operator
            201000 Cancel operator
            015020 Integrated ozone density
            010002 Height
            012101 Temperature
            013098 Integrated water vapour density
```

d) GOMOS *- The Global Ozone Monitoring by Occulation of Stars Gomos measures tangential atmospheric ultraviolet, visual and infrared light.*

*The BUFR template is the same as for **MIPAS** data*

e) MERIS - *The Medium Resolution Imaging Spectrometer: The instrument produces multi-spectral images obtained in a downward viewing push broom imaging manner. The 15 bands acquire radiance in the visible and near infra-red bands.*

BUFR table B reserved entries:

```
010080 VIEWING ZENITH ANGLE       DEGREE      2      -9000  15
027080 VIEWING AZIMUTH ANGLE      DEGREE TRUE 2          0  16
013093 CLOUD OPTICAL THICKNESS    NUMERIC     0          0   8
013095 TOTAL COLUMN WATER VAPOUR  KG/M**2     4          0  19
```

BUFR table D reserved entries:

```
312050      001007 Satellite identifier
            002019 Instrument type
            001096 Station acquisition
            025061 Software identification
            005040 Orbit number
            301011 Date
            301013 Time
            301021 Lat/long
            007025 Solar zenith angle
            005022 Solar azimuth
            010080 Viewing zenith angle
            027080 Viewing azimuth angle
            008003 Vertical significance
            007004 Pressure
            013093 Cloud optical thickness
            008003 Vertical significance
            201131 Change data width
            202129 Change scale
            007004 Pressure
            007004 Pressure
            202000 Cancel operator
            201000 Cancel operator
            013095 Total column water vapour
```

f) ASAR - The Advanced Synthetic Aperture Radar is a high resolution imaging radar.

```
Ocean cross spectra -   ( WVS )

312051     001007 Satellite identifier
           002019 Satellite instrument type
           001096 Station acquisition
           025061 Software identification
           005040 Orbit number
           008075 Ascending/descending orbit qualifier
           301011 Date
           301013 Time
           301021 Lat/long
           001012 Direction of motion of moving observing platform
           201131 Change data width
           001013 Speed of motion of moving observing platform
           201000 Cancel operator
           010032 Satellite distance to Earth centre
           010033 Altitude (platform to ellipsoid)
           010034 Earth radius
           007002 Height
           008012 Land/sea qualifier
           025110 Image processing summary
           025111 Number of input data gaps
           025102 Number of missing lines excluding data gaps
           002104 Antenna polarisation
           025103 Number of directional bins
           025104 Number of wave-length bins
           025105 First directional bin
           025106 Directional bin step
           025107 First wave-length bin
           025108 Last wave-length bin
           002111 Radar incidence angle
           002121 Mean frequency
           002026 Cross track resolution
           002027 Along track resolution
           021130 Spectrum total energy
           021131 Spectrum maximum energy
           021132 Direction of spectrum max on higher resolution grid
           021133 Wavelength of spectrum max on higher resolution grid
           021064 Clutter noise estimate
           025014 Azimuth clutter cut-off
           021134 Range resolution of cross covariance spectrum
           107018 Replicate next 7 descriptors 18 times
           005030 Direction (spectral)
           105024 Replicate 5 descriptors 24 time
           201130 Change data width
           006030 Wave number (spectral)
           201000 Cancel operator
           021135 Real part of cross spectra
           021136 Imaginary part of cross spectra
           033044 ASAR quality
```

New Table B descriptors

```
010032 SATELLITE  DISTANCE  TO  EARTH       M           1          0  27
       CENTRE
010033 ALTITUDE (PLATFORM TO ELLIPSOID)  M           1          0  27
010034 EARTH RADIUS                      M           1          0  27
025110 IMAGE PROCESSING SUMMARY          FLAG TABLE 0           0  10
025111 NUMBER OF INPUT DATA GAPS         NUMERIC    0           0   8
025102 NUMBER OF MISSING LINES EXCLUDING NUME      0           0   8
```

```
        DATA GAPS
025103 NUMBER OF DIRECTIONAL BINS       NUMERIC    0          0  8
025104 NUMBER OF WAVE-LENGHT BINS        NUMERIC    0          0  8
025105 FIRST DIRECTIONAL BIN            DEGREES    3          0  19
025106 DIRECTIONAL BIN STEP             DEGREES    3          0  19
025107 FIRST WAVE-LENGHT BIN            M          3          0  29
025108 LAST WAVE-LENGHT BIN             M          3          0  29
021130 SPECTRUM TOTAL ENERGY            NUMERIC    6          0  28
021131 SPECTRUM MAX ENERGY              NUMERIC    6          0  28
021132 DIRECTION OF SPECTRUM MAX ON     DEGREES    3          0  19
        HIGHER RESOLUTION GRID
021133 WAVE-LENGHT OF SPECTRUM MAX ON   M          3          0  29
        HIGHER RESOLUTION GRID
021134 RANGE RESOLUTION OF CRESS        RAD/M      3          0  19
        COVARIANCE SPECTRUM
021135 REAL PART OF CROSS SPECTRA       NUMERIC    3    -524288  20
        POLAR GRID NUMBER OF BINS
021136 IMAGINARY PART OF CROSS SPECTRA  NUMERIC    3    -524288  20
        POLAR GRID NUMBER OF BINS
033044 ASAR QUALITY INFORMATION         FLAG TABLE 0          0  15
```

Flag table 025110 IMAGE PROCESSING SUMMARY

```
 bit number        Meaning

   1               Raw data analysis used for raw data correction.
                   Correction done using default parameters
   2               Raw data analysis used for raw data correction.
                   Correction done using raw data analysis results
   3               Antenna elevation pattern correction applied
   4               Nominal chirp replica used
   5               Reconstructed chirp used
   6               Slant range to ground range Conversion applied
   7-9             Reserved
   All 10          Missing value
```

Flag table 033044 ASAR QUALITY INFORMATION

```
 bit number        Meaning

   1               Input data mean outside nominal range flag
   2               Input data standard deviation outside nominal range flag
   3               Number of input data gaps > threshold value
   4               Percentage of missing lines > threshold value
   5                Doppler centroid uncertain. Confidence measure <  specific
                   value
   6                Doppler ambiguity estimate uncertain. Confidence  measure <
                   specific value
   7               Output data mean outside nominal range flag
   8               Output data standard deviation outside nominal  range flag
   9               Chirp reconstruction failed or is of low quality  flag
  10               Data set missing
  11               Invalid downlink parameters
  12               Azimuth cut-off iteration count. The azimuth cut- off fit did
                   not converge within
                   minimum number of iterations
  13               Azimuth cut-off fit did not converge within a  minimum number
                   of iterations
  14                Phase information confidence measure. The  imaginary spectral
                   peak is less than
                   a minimum threshold, or the zero lag shift is  greater than a
                   minimum threshold
  All 15           Missing value
```

OCEAN WAVE SPECTRA

Table D sequence

```
312053    001007 Satellite identifier
          002019 Satellite instrument type
          001096 Station acquisition
          025061 Software identification and version number
          005040 Orbit number
          008075 Ascending/descending orbit qualifier
          301011 Date
          301013 Time
          301021 Lat/long
          001012 Direction of motion of moving observing platform
          201131 Change data width
          001013 Speed of motion of moving observing platform
          201000 Cancel operator
          010032 Satellite distance to Earth centre
          010033 Altitude (platform to ellipsoid)
          010034 Earth radius
          007002 Height or altitude
          008012 Land/sea qualifier
          025110 Image processing summary
          025111 Number of input data gaps
          025102 Number of missing lines excluding data gaps
          002104 Antenna polarisation
          025103 Number of directional bins
          025104 Number of wave-length bins
          025105 First directional bin
          025106 Directional bin step
          025107 First wave-length bin
          025108 Last wave-length bin
          011001 Wind direction
          011002 Wind speed
          022160 Normalized inverse wave age
          025138 Average signal to noise ratio
          201130 Change data width
          202129 Change scale
          022021 Height of waves
          202000 Cancel operator
          201000 Cancel operator
          033048 Confidence measure for SAR inversion
          033049 Confidence measure for wind retrieval
          002026 Cross track resolution
          002027 Along track resolution
          021130 Spectrum total energy
          021131 Spectrum max energy
          021132 Direction of spectrum max
          021133 Wave-length of spectrum max
          025014 Azimuth clutter cut-off
          106036 Replicate 6 descriptors 36 times
          005030 Direction (spectral)
          104024 Replicate 4 descriptors 24 time
          201130 Change data width
          006030 Wave number (spectral)
          201000 Cancel operator
          022161 Wave spectra
          033044 ASAR quality
```

Table B descriptors

```
022160 NORMALIZED INVERSE WAVE AGE   NUMERIC        6           0  21
025138 AVERAGE SIGNAL TO NOISE       NUMERIC        0        -2048  12
       RATIO
033048 CONFIDENCE MEASURE OF SAR     CODE TABLE     0           0   2
       INVERSION
033049 CONFIDENCE MEASURE OF WIND    CODE TABLE     0           0   2
       RETRIEVAL
022161 WAVE SPECTRA                  M**4           4           0  27
```

Code table 033048 CONFIDENCE MEASURE OF SAR INVERSION

```
 code figure          Meaning

   0                  inversion successful
   1                  inversion not successful
   2                  reserved
   3                  Missing
```

Code table 033049 CONFIDENCE MEASURE OF WIND RETRIEVAL

```
 code figure          Meaning

   0                  external wind direction used during inversion
   1                  External wind direction not used during  inversion
   2                  reserved
   3                  Missing
```

g) RA2 - Radar Altimeter-2

```
312052    001007 Satellite identifier
          002019 Satellite instrument type
          001096 Station acquisition
          025061 Software identification
          005040 Orbit number
          025120 Ra2 L2 processing flag
          025121 Ra2 L2 processing quality
          025124 MWR L2 processing flag
          025125 MWR L2 processing quality
          025122 Hardware configuration for RF
          025123 Hardware configuration for HPA
          301011 Date
          301013 Time
          301021 Lat/long
          007002 Height or altitude
          002119 Instrument operations
          033047 Measurement confidence data
          010081 Altitude of COG above reference ellipsoid
          010082 Instantaneous altitude rate
          010083 Off nadir angle of the satellite from platform data
          010084 Off nadir angle of the satellite from waveform data
          002116 Percentage of 320 MHz band processed
          002117 Percentage of 80 MHz band processed
          002118 Percentage of 20 MHz band processed
          002156 Percentage of valid Ku ocean retracker measurements
          002157 Percentage of valid S  ocean retracker measurements
          014055 Solar activity index
```

```
022150 Number of 18 Hz valid points for Ku band
022151 Ku band ocean range
022152 STD of 18Hz Ku band ocean range
022153 Number of 18 Hz valid points for S band
022154 S band ocean range
022155 STD of 18 Hz S band ocean range
022156 Ku band significant wave height
022157 STD of 18 Hz Ku band significant wave height
022158 S band significant wave height
022159 STD 18 Hz S band significant wave height
021137 Ku band corrected ocean backscatter coefficient
021138 STD Ku band corrected ocean backscatter coefficient
021139 Ku band net instrumental correction for AGC
021140 S band corrected ocean backscatter coefficient
021141 STD S band corrected ocean backscatter coefficient
021142 S band net instrumental correction for AGC
010085 Mean sea surface height
010086 Geoid height
010087 Ocean depth/land elevation
010088 Total geocentric ocean tide height solution 1
010089 Total geocentric ocean tide height solution 2
010090 Long period tide height
010091 Tidal loading height
010092 Solid earth tide height
010093 Geocentric pole tide height
011002 wind speed
025126 Model dry tropospheric correction
025127 Inverted barometer correction
025128 Model wet tropospheric correction
025129 MWR derived wet tropospheric correction
025130 Ra2 ionospheric correction on Ku band
025131 Ionospheric correction from Doris on Ku band
025132 Ionospheric correction  from model on Ku band
025133 Sea state bias correction on Ku band
025134 Ra2 ionospheric correction on S band
025135 Ionospheric correction from Doris on S band
025136 Ionospheric correction from model on S band
025137 Sea state bias correction on S band
013096 MWR water vapour content
013097 MWR liquid water content
011095 u component of model wind vector
011096 v component of model wind vector
012188 Interpolated 23.8 GHz brightness temp from MWR
012189 Interpolated 36.5 GHz brightness temp from MWR
002158 RA- 2 instrument
002159 MWR instrument
033052 S band ocean retracking quality
033053 Ku band ocean retracking quality
021143 Ku band rain attenuation
021144 Altimeter rain flag
```

Table B descriptors

```
002119 RA - 2 INSTRUMENT OPERATIONS       CODE TABLE   0      0    3
002116 PERCENTAGE OF 320 MHZ BAND PROCESSED %           0      0    7
002117 PERCENTAGE OF 80 MHZ BAND PROCESSED  %           0      0    7
002118 PERCENTAGE OF 20 MHZ BAND PROCESSED  %           0      0    7
002156 PERCENTAGE OF VALID KU OCEAN         %           0      0    7
       RETRACKER MEASUREMENTS
002157 PERCENTAGE OF VALID S OCEAN          %           0      0    7
       RETRACKER MEASUREMENTS
```

```
002158 RA - 2 INSTRUMENT                   FLAG TABLE   0       0   9
002159 MWR INSTRUMENT                      FLAG TABLE   0       0   8
010081 ALTITUDE OF COG ABOVE REFERENCE    M            3       0  31
       ELLIPSOID
010082 INSTANTANEOUS ALTITUDE RATE        M/S          3  -65536  17
010083 OFF NADIR ANGLE OF THE SATELLITE   DEGREE       2  -36000  17
       FROM PLATFORM DATA
010084 OFF NADIR ANGLE OF THE SATELLITE
       FROM WAVEFORM DATA                  DEGREE       2  -36000  17
010085 MEAN SEA SURFACE HEIGHT            M            3 -131072  18
010086 GEOID HEIGHT                        M            3 -131072  18
010087 OCEAN DEPTH/LAND ELEVATION          M            1 -131072  18
010088 TOTAL GEOCENTRIC OCEAN TIDE HEIGHT  M            3  -32768  16
       SOLUTION 1
010089 TOTAL GEOCENTRIC OCEAN TIDE HEIGHT  M            3  -32768  16
       SOLUTION 2
010090 LONG PERIOD TIDE HEIGHT            M            3  -32768  16
010091 TIDAL LOADING HEIGHT               M            3  -32768  16
010092 SOLID EARTH TIDE HEIGHT            M            3  -32768  16
010093 GEOCENTRIC POLE TIDE HEIGHT        M            3  -32768  16
011095 U COMPONENT OF THE MODEL WIND      M/S          1   -4096  13
       VECTOR
011096 V COMPONENT OF THE MODEL WIND      M/S          1   -4096  13
       VECTOR
012188 INTERPOLATED 23.8 GHZ BRIGHTNESS T K            2       0  16
       FROM MWR
012189 INTERPOLATED 36.5 GHZ BRIGHTNESS T K            2       0  16
       FROM MWR
013096 MWR WATER VAPOUR CONTENT           KG/M**2      2       0  14
013097 MWR LIQUID WATER CONTENT           KG/M**2      2       0  14
014055 SOLAR ACTIVITY INDEX              NUMERIC       0  -32768  16
021137 KU BAND CORRECTED OCEAN            DB           2  -32768  16
       BACKSCATTER COEFFICIENT
021138 STD KU BAND CORRECTED OCEAN        DB           2  -32768  16
       BACKSCATTER COEFFICIENT
021139 KU BAND NET INSTRUMENTAL           DB           2   -2048  12
       CORRECTION FOR ACG
021140 S  BAND CORRECTED OCEAN            DB           2  -32768  16
       BACKSCATTER COEFFICIENT
021141 STD S  BAND CORRECTED OCEAN        DB           2  -32768  16
       BACKSCATTER COEFFICIENT
021142 S  BAND NET INSTRUMENTAL           DB           2   -1024  11
       CORRECTION FOR ACG
021143 KU BAND RAIN ATTENUATION           DB           2 -1073741824  31
021144 ALTIMETER RAIN FLAG                FLAG TABLE   0       0   2
022150 NUMBER OF 18 HZ VALID POINTS      NUMERIC       0       0  10
       FOR KU BAND
022151 KU BAND OCEAN RANGE                M            3       0  31
022152 STD OF 18 HZ KU BAND OCEAN RANGE   M            3       0  16
022153 NUMBER OF 18 HZ VALID POINTS FOR  NUMERIC       0       0  10
       S  BAND
022154 S BAND OCEAN RANGE                 M            3       0  31
022155 STD OF 18 HZ S BAND OCEAN RANGE    M            3       0  16
022156 KU BAND SIGNIFICANT WAVE HEIGHT    M            3       0  16
022157 STD 18 HZ KU BAND SIGNIFICANT      M            3       0  16
       WAVE HEIGHT
022158 S  BAND SIGNIFICANT WAVE HEIGHT    M            3       0  16
022159 STD 18 HZ S  BAND SIGNIFICANT WAVE M            3       0  16
       HEIGHT
025120 RA2_L2_PROCESSING FLAG            CODE TABLE    0       0   2
025121 RA2_L2_PROCESSING QUALITY         %             0       0   7
025122 HARDWARE CONFIGURATION FOR RF     CODE TABLE    0       0   2
025123 HARDWARE CONFIGURATION FOR HPA    CODE TABLE    0       0   2
```

```
025124 MWR L2 PROCESSING FLAG           CODE TABLE   0        0   2
025125 MWR L2 PROCESSING QUALITY        %            0        0   7
025126 MODEL DRY TROPOSPHERIC CORRECTION M           3   -32768  16
025127 INVERTED BAROMETER CORRECTION    M            3   -32768  16
025128 MODEL WET TROPOSPHERIC CORRECTION M           3   -32768  16
025129 MWR DERIVED WET TROPOSPHERIC      M            3   -32768  16
       CORRECTION
025130 RA2 IONOSPHERIC CORRECTION ON KU  M           3   -32768  16
       BAND
025131 IONOSPHERIC CORRECTION FROM DORIS M           3   -32768  16
       ON KU BAND
025132 IONOSPHERIC CORRECTION FROM MODEL M           3   -32768  16
       ON KU BAND
025133 SEA STATE BIAS CORRECTION ON      M           3   -32768  16
       KU BAND
025134 RA2 IONOSPHERIC CORRECTION ON S   M           3   -32768  16
       BAND
025135 IONOSPHERIC CORRECTION FROM DORIS M           3   -32768  16
       ON S BAND
025136 IONOSPHERIC CORRECTION FROM MODEL M           3   -32768  16
       ON S BAND
025137 SEA STATE BIAS CORRECTION ON S    M           3   -32768  16
       BAND
033052 S  BAND OCEAN RETRACKING QUALITY  FLAG TABLE   0        0  21
033053 KU BAND OCEAN RETRACKING          FLAG TABLE   0        0  21
       QUALITY
033047 MEASUREMENT CONFIDENCE DATA FLAG TABLE         0        0  31
```

Code table 002180   INSTRUMENT OPERATIONS

```
 Code figure          Meaning

     0                Intermediate Frequency Calibration Mode (IF CAL)
     1                Built-In Test Equipment Digital (BITE DGT)
     2                Built-In test Equipment Radio Frequency (BITE RF)
     3                Preset tracking ( PSET TRK)
     4                Preset LOOP OUT
     5                ACQUISITION
     6                TRACKING
     7                MISSING VALUE
```

Flag table 002158   RA - 2 INSTRUMENT

```
 bit number           Meaning

     1                MISMATCH IN RED VEC HPA
     2                MISMATCH IN RED VEC RFSS
     3                PTR CALIBRATION BAND 320 MHz (Ku)
     4                PTR CALIBRATION BAND 80 MHz (Ku)
     5                PTR CALIBRATION BAND 20 MHz (Ku)
     6                PTR CALIBRATION BAND 160 MHz (S)
     7                Ku FLIGHT CALIBRATION PARAMETERS AVAILABLE
     8                S FLIGHT CALIBRATION PARAMETERS AVAILABLE
     All              Missing value

Note: PTR - Pulse target response
      HPA - High Power Amplifier
      RFSS - Radio Frequency Sub-System
      RED - Redundancy
```

Flag table 002159   MWR INSTRUMENT

bit number	Meaning
1	Temperature inconsistency
2	Data is missing
3	Redundancy channel
4	Power bus protection
5	Overvoltage/Overload protection
6	Reserved
7	Reserved
ALL	Missing

Note: MWR - Microwave radiometer

Flag table 021144   Altimeter rain flag

bit number	Meaning
1	RAIN
all	Missing value

Code table 025120   RA2_l2_processing flag

code figure	Meaning
0	Percentage of DSRs free of processing errors during Level 2 processing is greater than the acceptable threshold
1	Percentage of DSRs free of processing errors during Level 2 processing is less than the acceptable threshold
2	Reserved
3	Missing value

Note: DSR - Data set record

Code table 025122   Hardware configuration for RF

Code figure	Meaning
0	Hardware configuration for RF is A
1	Hardware configuration for RF is B
2	Reserved
3	Missing

Note: RF - Radio frequency

Code table 025123   Hardware configuration for HPA

Code figure	Meaning
0	Hardware configuration for HPA is A
1	Hardware configuration for HPA is B
2	Reserved
3	Missing

Code table 025124   MWR l2 processing flag

Code figure	Meaning
0	Percentage of DSRs free of processing errors during

```
                      Level 2 processing is greater than the acceptable threshold
       1              Percentage of DSRs free of processing errors during
                      Level 2 processing is less than the acceptable threshold
       2              Reserved
       3              Missing
```

Note: DSR - Data Set Record
      MWR - Microwave radiometer

Flag table 033053   Ku band ocean retracking quality

```
  bit number          Meaning

    1-20              First 20 least significant bits correspond to the 20 values
                      (one  per  data  block  containing  0=valid  measurement,
                      1=invalid)
                      bit 1 applies to the 20th data block
    All               Missing
```

Flag table 033052   S band ocean retracking quality

```
  bit number          Meaning

    1-20              First 20 least significant bits correspond to the 20 values
                      (one  per  data  block  containing  0=valid  measurement,
                      1=invalid)
                      bit 1 applies to the 20th data block
    All               Missing
```

Flag table 033047   Measurement confidence data

```
  bit number          Meaning

    1                 Error detected and attempts to recover made
    2                 Anomaly in on-board data handling  (OBDH) value detected
    3                  Anomaly in Ultra Stable Oscillator Processing (USOP) value
                      detected
    4                 Errors detected by on-board computer
    5                 Automatic gain control (AGC) out of range
    6                 Rx delay fault. Rx distance out of range
    7                 Wave form samples fault identifier. Error
    8                 Reserved
    9                 Reserved
   10                 Reserved
   11                 Reserved
   12                 Brightness temperature (channel 1) out of range
   13                 Brightness temperature (channel 2) out of range
   14                 Reserved
   15                 Ku Ocean retracking error
   16                 S Ocean retracking error
   17                 Ku Ice 1 retracking error
   18                 S Ice 1 retracking error
   19                 Ku Ice 2 retracking error
   20                 S Ice 2 retracking error
   21                 Ku Sea Ice retracking error
   22                 Arithmetic fault error
   23                 Meteo data state. No map
   24                 Meteo data state. 1 map
   25                 Meteo data state 2 maps degraded
   26                 Meteo data state 2 maps nominal
   27                 Orbit propagator status for propagation mode, several errors
```

```
    28              Orbit propagator status for propagation mode, warning
                detected
    29               Orbit propagator status for initialisation mode, several
                errors
    30              Orbit  propagator  status  for  initialisation  mode,  warning
                detected
All 31               Missing
```

ADD NEW DESCRIPTOR FOR:

```
          Satellite zenith angle
          0-07-026 Degrees      4       -900000      21
          B-07-026 Degrees      4                    7
```

ADDITION FOR REPRESENTING WAVE SPECTRA

```
002120  Ocean wave frequency      Hz       3   0    10 bits
022069  Spectral wave density     M²Hz⁻¹   3   0    22 bits
```

Satellite Radio Occultation data in BUFR

[Note: The text related to Satellite Radio Occultation data in BUFR is the Appendix to CBS-XIII/Doc. 5.2(3), ADD.1, APPENDIX]

New Table B descriptors

F X Y	Element name	BUFR				CREX		
0 07 040	Impact parameter	m	1	62000000	22	m	1	8
0 10 035	Earth's local radius of curvature	m	1	62000000	22	m	1	8
0 10 036	Geoid undulation	m	2	-15000	15	m	2	6
0 15 036	Atmospheric refractivity	N-units	3	0	19	N-units	3	6
0 15 037	Bending angle	Radians	8	-100000	23	Radians	8	7
0 33 039	Quality flags for Radio Occultation data	Flag table	0	0	16	Flag table	0	6

Additional notes to Table B

Class 07.

(8) For an atmospheric limb sounder, the "impact parameter" is the distance between the ray asymptote and the centre of curvature of the Earth's surface at the tangent point.

Class 10

(4) The "geoid undulation" is the difference between the reference ellipsoid (WGS-84) and the geoid height (EGM96) at the geographic location of the observation, both referenced to the centre of mass of the Earth.

Class 15

(5) The refractivity, *N*, is related to the refractive index, *n* by the formula $N = 10^6 (n - 1)$. *N* is therefore dimensionless but values computed by the formula are by convention described as being in 'N-units'.

New Flag Table

Descriptor	*Bit*	
033039	1	Non-nominal quality
	2	Offline product
	3	Ascending occultation flag
	4	Excess Phase processing non-nominal
	5	Bending Angle processing non-nominal
	6	Refractivity processing non-nominal
	7	Meteorological processing non-nominal
	8-13	Reserved
	14	Background profile non-nominal
	15	Background (i.e. not retrieved) profile present
	All 16	Missing value

New Table D entry – Common Sequence

(Satellite radio occultation data)

310026	310022	Satellite, instrument and product information
	025060	Software identification
	008021	Time significance ('17' = start of phenomenon)
	301011	Year, month, day
	301012	Hour, minute
	201138	Change width to 16 bits
	202131	Change scale to 3
	004006	Second
	202000	Change scale back to Table B
	201000	Change width back to Table B
	033039	Quality flags for Radio Occultation data
	033007	Per cent confidence (for whole message)
	304030	Location of platform
	304031	Speed of platform
	002020	Satellite classification
	001050	Platform transmitter ID number
	202127	Change scale to 1
	304030	Location of platform
	202000	Change scale back to Table B
	304031	Speed of platform
	201133	Change width to 18 bits
	202131	Change scale to 3
	004016	Time increment
	202000	Change scale back to Table B
	201000	Change width back to Table B
	301021	Latitude, longitude (high accuracy)
	304030	Location of point
	010035	Earth's local radius of curvature
	005021	Bearing or azimuth
	010036	Geoid undulation

```
113000 Delayed replication of 13 descriptors
031002 Replication factor (16 bits)
301021 Latitude, longitude (high accuracy)
005021 Bearing or azimuth
108000 Delayed replication of 8 descriptors
031001 Replication factor
002121 Mean frequency
007040 Impact parameter
015037 Bending angle
008023 First-order statistics ('13' = r.m.s.)
201125 Change width to 20 bits
015037 Bending angle
201000 Change width back to Table B
008023 First-order statistics ('63' = missing)
033007 Per cent confidence (all data for current replication)
108000 Delayed replication of 8 descriptors
031002 Replication factor (16 bits)
007007 Height
015036 Atmospheric refractivity
008023 First-order statistics ('13' = r.m.s.)
201123 Change width to 14 bits
015036 Atmospheric refractivity
201000 Change width back to Table B
008023 First-order statistics ('63' = missing)
033007 Per cent confidence (all data for current height)
116000 Delayed replication of 16 descriptors
031002 Replication factor (16 bits)
007009 Geopotential height
010004 Pressure
012001 Temperature
013001 Specific humidity
008023 First-order statistics ('13' = r.m.s.)
201120 Change width to 6 bits
010004 Pressure
201000 Change width back to Table B
201122 Change width to 6 bits
012001 Temperature
201000 Change width back to Table B
201123 Change width to 9 bits
013001 Specific humidity
201000 Change width back to Table B
008023 First-order statistics ('63' = missing)
033007 Per cent confidence (all data for current height)
008003 Vertical significance ('0' = surface)
007009 Geopotential height
010004 Pressure
008023 First-order statistics ('13' = r.m.s.)
201120 Change width to 6 bits
010004 Pressure
201000 Change width back to Table B
008023 First-order statistics ('63' = missing)
033007 Per cent confidence (for surface data)
```

ADDITIONS TO FM 94-XII Ext. BUFR AND FM 95-XII Ext. CREX for a new edition

Additions relative to a new edition of BUFR

NEW OPERATOR WITHIN BUFR TABLE C TO SIMPLIFY THE PROCEDURE OF INCREASING DESCRIPTOR PRECISION

New BUFR Table C operator descriptor:

Table Reference:
    2-07-Y

Operator Name:
    Increase scale, reference value and data width

Operator Definition:
    For Table B elements, which are not CCITT IA5 (character data), code tables, or flag tables:

1. Add Y to the existing scale factor

2. Multiply the existing reference value by 10^{Y}.

3. Calculate $((10 \times Y) + 2) \div 3$, disregard any fractional remainder and add the result to the existing bit width.

Reword of Notes to BUFR Table C as follows:

(1)   The operations specified by operator descriptors 2 01, 2 02, 2 03, 2 04, and 2 07 remain defined until cancelled or until the end of the subset.

(4)   Nesting of operator descriptors must guarantee unambiguous interpretation. In particular, operators defined within a set of replicated descriptors must be cancelled or completed within that set, and the 2 07 operator may not be nested within any of the 2 01, 2 02, and 2 03 operators, nor vice-versa.

MODIFY REGULATION 1 TO SAY:

1   Each section included in the code form shall always contain an integer multiple of 8 bits (octet). This rule shall be applied by appending bits set to zero to the section where necessary.

Change entry 255 in BUFR Table A Data Category and CREX Table A Data Category:

255   Other category

NEW COMMON CODE TABLE C-13: Data sub categories of categories defined by entries in BUFR

Table A

Data categories		International data sub-categories	
BUFR octet 11 *CREX nnn in group Annnmmm*		*BUFR octet 12* (if = 255, it means other sub-category or undefined) *CREX mmm in group Annnmmm*	
Code figure	**Name**	**Code**	**Name** (corresponding traditional alphanumeric codes are in brackets)
000	Surface data — land	*000*	*Hourly synoptic observations from fixed-land stations (SYNOP)*
		001	*Intermediate synoptic observations from fixed-land stations (SYNOP)*
		002	*Main synoptic observations from fixed-land stations (SYNOP)*
		003	*Hourly synoptic observations from mobile-land stations (SYNOP MOBIL)*
		004	*Intermediate synoptic observations from mobile-land stations (SYNOP MOBIL)*
		005	*Main synoptic observations from mobile land stations (SYNOP MOBIL)*
		006	*One-hour observations from automated stations*
		007	*n-minute observations from AWS stations*
		010	*Routine aeronautical observations (METAR)*
		011	*Special aeronautical observations (SPECI)*
		020	*Climatological observations (CLIMAT)*
		030	*Spherics locations (SFLOC)*
		040	*Hydrologic reports*
001	Surface data — sea	*000*	*Synoptic observations (SHIP)*
		006	*One-hour observations from automated stations*
		007	*n-minute observations from AWS stations*
		020	*Climatological observations (CLIMAT SHIP)*
		025	*Buoy observation (BUOY)*
		030	*Tide gauge*
		031	*Observed water level time series*
002	*Vertical soundings (other than satellite)*	*001*	*Upper-wind reports from fixed-land stations (PILOT)*
		002	*Upper-wind reports from ships (PILOT SHIP)*
		003	*Upper-wind reports from mobile-land stations (PILOT MOBIL)*
		004	Upper-level temperature/humidity/wind reports from fixed-land stations (TEMP)

		005	Upper-level temperature/humidity/wind reports from ships (TEMP SHIP)
		006	Upper-level temperature/humidity/wind report from mobile-land stations (TEMPMOBIL)
		007	Upper-level temperature/humidity/wind reports from dropwinsondes (TEMP DROP)
		010	Wind profiler reports
		011	RASS temperature profiles
		020	ASDAR/ACARS profiles (AMDAR)
		025	Climatological observations from fixed-land stations (CLIMAT TEMP)
		026	Climatological observations from ships (CLIMAT TEMP SHIP)
003	Vertical soundings (satellite)	000	Temperature (SATEM)
		001	TIROS (TOVS)
004	*Single level upper-air data (other than satellite)*	000	ASDAR/ACARS (AMDAR)
		001	Manual (AIREP, PIREP)
005	*Single level upper-air data (satellite)*	000	Cloud wind data (SATOB)
006	*Radar data*	000	Reflectivity data
		001	Doppler wind profiles
		002	Derived products
		003	Ground radar weather (RADOB)
007	*Synoptic features*	000	Forecast Tropical cyclone tracks from EPS
008	*Physical/chemical constituents*	000	Ozone measurement at surface
		001	Ozone vertical sounding
009	*Dispersal and transport*	000	Trajectories, analysis or forecast
010	*Radiological data*	001	Observation (RADREP)
		002	Forecast (RADOF)
012	*Surface data (satellite)*	000	ERS-uwa
		001	ERS-uwi
		002	ERS-ura
		003	ERS-uat
		004	SSM/I radiometer
		005	Quickscat
		006	Surface temp./radiation (SATOB)
031	Oceanographic data	*000*	Surface observation
		001	Surface observation along track (TRACKOB)
		002	Spectral wave observation (WAVEOB)
		003	Bathythermal observation (BATHY)
		004	Sub surface floats (profile)
		005	XBT/XCTD profiles (TESAC)
		006	Waves reports

Proposed modified Section 1 for BUFR Edition 4:

1-3   *Length of section*
4   *BUFR master table*
5-6   Identification of originating/generating centre (see Common Code Table C-11)
7-8   Identification of originating/generating sub-centre (allocated by originating/generating Centre- see Common Code Table C-12)
9   Update sequence number (zero for original BUFR messages; incremented for updates)

10   Bit 1   =0   No optional section
                =1   Optional section follows
           Bit 2-8   Set to zero (reserved)

11   Data Category (Table A)

12   International data sub-category (See Common Table C-13 – see Note (3))

13   Local data sub-category (defined locally by automatic data processing (ADP) centres –see Note (3))

14   Version number of master table (currently 12 for WMO FM 94 BUFR tables – see Note (2))

15   Version number of local tables used to augment master table in use – see Note (2)

16-17   Year (4 digits) |

18   Month |

19   Day | Most typical time for the BUFR message content – see Note (4)

20   Hour |

21   Minute |

22   Second |

23-   Reserved for local use by ADP centres

Replace note (3) and add new Notes:

(3)   The local data sub-category is maintained for backwards-compatibility with editions 0-3 of BUFR, since many ADP centres have made extensive use of such values in the past. The international data sub-category introduced with edition 4 of BUFR is intended to provide a mechanism for better understanding of the overall nature and intent of messages exchanged between ADP centres. These two values (i.e. local sub-category vs. international sub-category) are intended to be supplementary to one another, so both may be used within a particular BUFR message.

(4)   When accuracy of the time does not define a time unit, then the value for this unit is set to zero (e.g. SYNOP observation at 09 UTC, then Minute =0, Second=0).