WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

OPAG ON INFORMATION SYSTEMS AND SERVICES

JOINT MEETING OF EXPERT TEAM ON DATA REPRESENTATION AND CODES AND COORDINATION TEAM OF MIGRATION TO TABLE DRIVEN CODE FORMS

FINAL REPORT

MONTREAL, CANADA, 8-12 May 2006

EXECUTIVE SUMMARY

The joint Meeting of the Coordination Team on Migration to Table Driven Code Forms and the Expert Team on Data Representation and Codes was held, at the kind invitation of ICAO in Montreal, from 8 to 12 May 2006.

The Team reviewed the status of validation tests for FM 92 GRIB Edition 2. Still validation tests were needed for the templates related to the encoding/decoding of cross-sections, Hovmöller type diagrams. More commitment from ICAO were needed to undertake acceptance of the Weather-Huffman compression. The Team agreed to some additions of templates in GRIB 2 Tables, mainly for lossless IEEE floats packing and simple packing. USA reported on new products available in GRIB 2, and their plan for making all products available in GRIB 2. China was planning to produce GRIB 2 fields within the next few years.

The Team examined various requirements, which had been expressed for additions to BUFR/CREX Tables. The descriptors for transmission of SIGMET in BUFR were recommended for pre-operational status. Descriptors combining requests from Canada, USA and the GEMS project were recommended for Air Chemistry data, seeking urgent validation. Clarifications to some BUFR regulations were approved. Numerous additions for the new European polar orbiting satellite instruments data (MHS, IASI, ASCAT) were recommended for pre-operational status. At the request of Japan, additions were recommended for pre-operational status for reporting in BUFR tropical cyclone observations performed by satellite and Radar. Additions were recommended for height of temperature sensor in SST measurement by ship and also for representation of nominal values. More validation were requested for new descriptors of Global Ocean Data Assimilation Experiment (GODAE) high-resolution sea surface temperature pilot project (GHRSST-PP) data. .

ICAO passed to the Team for recommendation the proposed changes to the aeronautical codes FM 15, FM 16 and FM 51, which form part of draft Amendment 74 to ICAO Annex 3/ WMO Technical Regulations [C.3.1.]. The Team agreed that the proposals looked correct. The Team recalled that the biennial regular sessions of CBS imposed constraints on the dates where changes to aeronautical codes (FM 15 METAR/SPECI AND FM 51 TAF) could be implemented. The Team stressed again there was a need of respecting an agreed calendar and that the adaptation of ICAO of this calendar for the changes to codes was imperative. A calendar with planned dates for approval of code changes and implementation for the next 4 years was proposed.

The Team reviewed the status of the migration and noted that more BUFR bulletins were exchanged than recorded in the WMO monitoring file. The last information showed that:

–Many RA VI countries are working for development and starting production:

•Czech Republic, Germany, Netherlands and Slovakia are disseminating AWS observations in BUFR, Israel: TEMP, PILOT, SYNOP and SHIP data in BUFR, Jordan (SYNOP), France (SYNOP), Czech Republic produces TEMP in BUFR, and ozone sounding and soil temperature in CREX

–RA V: Australia produces SYNOP in BUFR for Australia and Papua New Guinea and works for other data types

–RA IV: USA produces upper-air data in BUFR, and sea level data in CREX. Mexico tested encoding of SYNOP, TEMP, CLIMAT and CLIMAT TEMP. Costa Rica works on implementation.

–RA III: Brazil works seriously on implementation.

–RA II: Japan Meteorological Agency is disseminating since November 2005 SYNOP, SHIP, TEMP, TEMPSHIP, TRACKOB, TESAC, BATHY, CLIMAT, CLIMAT, RADOB, SAREP; SATOB data in BUFR - China will produce SYNOP in BUFR in 2007.

–RA I: Some African countries are working seriously on the migration: e.g. Botswana, Ethiopia, Morocco, Mozambique, Senegal, Tanzania. Some are considering to use CREX (more metadata more precision and more flexibility compare to traditional SYNOP code).

ICAO wished to target completion of migration to BUFR in 2016, and needed to keep use of GRIB Edition 1 up to 2010.

The Team agreed for a solution to transmit Corrected, Amended, Delayed and NIL BUFR binary bulletins, as well as NIL report within a BUFR message containing a set of reports. The Team also confirmed that non-standard units will be allowed in BUFR for only aviation usage.

The Team congratulated Dr Eva Cervena who presented the final regulations for reporting almost all TAC data in BUFR, including relevant regional practices. The Team was impressed by the work accomplished and recommended that these templates be pre-operational. Validation of the regional templates might be done in cooperation with the Working Groups on Planning and Implementation of WWW in RAs. The Team proposed that descriptors representing national practices in TDCF be developed by the countries themselves. The Team examined also proposed templates for buoy wave data, high-resolution radiosonde and METAR/SPECI and TAF. These templates need more validation, especially the METAR/SPECI and TAF templates to be operational on 7 November 2007. William Chillambo, the representative from Tanzania, reported on the activities in Tanzania

especially for training on the use and encoding of data in CREX. This training was also shared with neighbouring countries. The Team agreed that more assistance should be provided to countries in Africa like Tanzania. The representative of the Secretariat reported that Countries from West RA I were planning to implement a CREX code for describing squall lines.

Two representative of HMEI, Mr Paul Heppner from 3SI (USA) and Mr Michal Weis from IBL software Engineering (Slovak Republic) attended the Meeting as observers. Mr Weis reported on his experience with implementation of BUFR encoder/decoders. He observed a significant gap between TDCF producers and the final users at the data-processing level. Both groups have different expectations from the software, from the data processing and have a different level of knowledge of data. The main reasons for this dichotomy were probably the common misunderstanding resulting from not making a difference between decoding and understanding/interpretation.

The Team repeated that XML could be a useful exchange mechanism for small amounts of data and that some WMO guidance on nomenclature, conventions and/or best practices might be useful in order to assist member countries in this effort. However, there had been minimal XML experience reflected within the existing membership of the ET/DR+C, so the need to involve additional subject-matter experts was repeatedly emphasized. USA and UK reported on their usage of XML for specific data exchanges. The U.S.A has a substantial body of work to share in such an effort, and would like to volunteer involvement in all steps of the development and decision process for any such future guidance, best practices, and associated WMO standards for XML. The Meeting considered that NetCDF was array driven and file oriented, and that it was more appropriate for fields than for observations. It was somehow acceptable for data retrieval, but surely unusable for real time automatic operational exchange on the GTS. The Meeting repeated the need to hire a consultant to establish the exact requirements, to define the tasks to put standards for parameters in a convention, how to link it with GRIB 2 and identify what had to be done.

The Meeting considered the tasks needed to improve the process for migration to TDCF and realized that numerous tasks remained to be done, especially for helping developing countries. The Meeting considered how to provide central coordination of activities including preoperational testing and operational implementation. As stated in its terms of reference, the CT recognized the need to coordinate its activities and work together with other relevant international bodies. The Meeting was informed of contacts with ICAO, CAeM, IOC, JCOMM and the satellite operators in order to co-ordinate, agree and resolve migration issues related to specific code types. The Team stressed also the need to coordinate with Regional Focal Points, National Migration Steering Groups and Codes Focal Points, RTH Focal Points and others too, as needed, to identify problems and develop and implement solutions. Information should be passed to the Regional Rapporteurs on Codes and Data Management or ISS. The Meeting reviewed the achieved training activities and considered new ways, aiming at more efficiency, to train countries to implement the migration.

The CT agreed that there was a problem of visibility of the migration. The CT recommended that a special information should be sent again to the PRs, in the shape of a letter accompanied with a one page information giving the main lines of actions to be taken, then an annex which would be called Migration Guidance. The Migration Guidance document will be targeted at the executive management, who would then become aware of the migration and relay the information to the experts involved more specifically with the different aspects of the implementation of the migration to TDCF. The Meeting reviewed further the concept of pilot programmes and made recommendations for their implementation with a view to help developing countries. It decided that Migration Implementation Programmes (MIPs) should be supported if they have implementation as the defined result of their completion. It also decided these programmes should integrate the recommendations of the migration plan. The Meeting agreed to develop a template and guidance for a MIP and to make it available on an improved migration web site.

Finally the Meeting considered a proposal to split the ET/DR&C in two teams (a Data Definitions Working Group and a Data Infrastructure Expert Team) and found that this would not be workable for two reasons:

i. The change of structure is definitely connected with the requirement for additional features to data representation, which have to be analyzed in themselves, and might lead to structure changes, but not always.
ii. The volume of work for TDCF codes is largely enough for a single team. Mixing expertise of the Team in NetCDF and XML would require a much bigger membership, with people working virtually independently.

To push XML and NetCDF two other teams need to be created to work with their own agenda. One could foresee sometimes a common meeting between the 2 or 3 teams to ensure commonality of standard definitions where it is required.

TABLE OF CONTENTS

REPORT OF THE JOINT MEETING OF EXPERT TEAM ON DATA REPRESENTATION AND CODES AND COORDINATION TEAM OF MIGRATION TO TABLE DRIVEN CODE FORMS

(Montreal, Canada, 8-12 May 2006)

1. ORGANIZATION OF THE MEETING

1.1 OPENING OF THE MEETING

1.1.1 At the kind invitation of the International Civil Aviation Organization (ICAO), the joint Meeting of the Expert Team on Data Representation and Codes (ET/DR&C) and Coordination Team of Migration to Table Driven Code Forms took place in the Headquarters of ICAO in Montreal from 8 to 12 May 2006 (the participants' list can be found in the Annex to this paragraph). The Meeting was opened on Monday 8 May 2006 at 9.30 a.m. by Mr Bill Voss, Director of Air Navigation Bureau. He welcomed the Experts and said that ICAO was honored to host this meeting. He acknowledged the good work made by these Teams to develop technical solutions to satisfy, among many others, in particular the requirements of the aviation community. He also indicated that ICAO will ensure in the future the synchronization of changes to codes done by WMO with the dates of implementation of changes for required meteorological information by ICAO. He wished the Experts a good stay in Montreal.

1.1.2 The representative of the WMO Secretariat thanked ICAO for the excellent hospitality. He also thanked the local organizers, especially Oli Turpeinen and Neil Halsey who worked, with their staff for the local arrangements. He stressed that civil aviation has always been and is still the main customer of meteorological services and that it was normal that civil aviation requirements were taken seriously by WMO, and when possible, the Expert Teams were accommodating those requirements in priority, like accepting non-standard units in BUFR. However, WMO had also its own needs, like the necessary migration to Table Driven Code Forms. This was a long process, which was not forcing ICAO to adopt drastic changes in data representation. It would be a slow process. The data flow process was sometimes not clear for some community. The functions of transmission and visualization were sometimes wrongly confused, and appropriate format conversion was always a possibility to satisfy the user. It was often forgotten that the WMO codes were fundamental to meteorology because they make possible the real time exchange of data, which is the raw material for all meteorological processing and applications. The experts would have challenging tasks on the agenda for this week, and they would have to make recommendations with a view to their adoption by CBS.

1.1.3 Mr Milan Dragosavac from ECMWF, Chairman of the Expert Team on Data Representation and Codes, after having thanked ICAO for hosting the meeting, welcomed the participants. He then led the Meeting with diplomacy and efficiency for items 1 to 4. Mr Fred Branski, chairman of the Coordination Team of Migration to Table Driven Code Forms followed to lead the Meeting with diplomacy for items 5 to 8.

1.2 APPROVAL OF THE AGENDA

The Meeting agreed to the content of the agenda as proposed (see Table of Contents in front).

2. GRIB 2 CODE FORM

2.1 STATUS AND COORDINATION OF VALIDATION TESTS FOR GRIB2 ENCODING/DECODING

2.1.1 Validation of special templates for the transmission in GRIB 2 of cross-sections and Hovmöller type diagrams

The Meting found again that no work had been undertaken to attempt the validation of the templates related to the encoding/decoding of cross-sections and Hovmöller type diagrams. The need for the exchange of these types of data might arise at some stage.

2.1.2 Validation of Weather Huffman (WH) compression scheme

The representative of NCEP, Mr Jeff Ator reported that, although the WH scheme was very efficient for compression of radar reflectivity images, there was no official requirement from ICAO to pass radar data in WH format to the cockpit and that there was no demand for the use of WH by ICAO for the moment. The ICAO will report about this requirement at the next meeting of this group. Since the conditions expressed by the Team in Oman were not implemented, that is: (1) some recognized organization accepts to be the official custodian and maintainer of the algorithm and (2) ICAO provides a commitment that they will actually use it, there was no need to pursue the inclusion of WH in GRIB 2 for the time being.

2.2 OTHER ADDITIONS OR MODIFICATIONS

2.2.1 Parameters for GEMS (Global and regional Earth-system Monitoring using Satellite and in situ data)

ECMWF indicated that the proposal was still in the refinement process and that it will need to be revisited at a later stage.

2.2.2 Simple packing

ECMWF had noted that the Guide on FM-92 GRIB Edition 2 (page 38) states that the increments should be created by subtracting minimum value of the field from each field value; whereas, GRIB packing and unpacking must be symmetrical in the sense that the same values shall be used in packing/unpacking process. Since R (the reference value) is stored as IEEE 32 bit floating point number, its value can be slightly different from the field minimum value and cause problems specially when dealing with small numbers. ECMWF proposed to use always IEEE 32 bit floating point R number for increment and binary scale factor calculation instead of minimum value of grid. R shall be the largest IEEE 32 bit representation, which is smaller or equal than minimum value. This requires an amendment of Step 3 in the Guide as listed in Annex to this paragraph. The Meeting agreed to this modification and recommended that this was the opportunity to check the Guide and list any other possible needed amendments.

2.2.3 Discrepancy in template 4.30 Satellite product

The Product Definition Table 4.30, Satellite Product, contains:

Satellite series
Satellite number
Instrument type

The note recommends the usage of 002020, Common table C-5 and Common table C-8 respectively for those elements. However in all three tables there were entries occupying more than 8 bits. The

Meeting agreed to deprecate template 4.30 and make a new template 4.31 PDT for Satellite Product with (see Annex to this paragraph) with two octets for each of the mentioned entries.

2.2.4 Lossless packing

ECMWF expressed a difficulty met with some chemical fields, where values are not of the same range within a grid. And when sharing a scale factor between all values strong quantization errors can be introduced. Therefore new templates were proposed where no assumption was made on the data, and one simply uses IEEE floats for data packing. The Team agreed to introduce these new templates for preoperational status as listed in Annex to this paragraph.

2.2.5 Other modifications or additions to GRIB 2

2.2.5.1 Orthogonality of parameter definition

One of the objectives for introducing the new GRIB2 format was to overcome the limitations for identifying a parameter in GRIB1. It was agreed to introduce a *branching structure* to allow a unique identification of parameters. According to the GRIB 2 manual the parameter is identified by three entities:

- Discipline (specified in Section 0),
- Category (specified in section 4),
- Parameter number (specified in section 4).

This statement is only to some extent correct and might cause trouble in certain circumstances. The Discipline, Category, Parameter number are most often not sufficient to identify the meteorological field uniquely, for example Sea surface temperature, Maximum 2m temperature, Temperature on isobaric levels are all expressed by the same three temperature entity, even so they represent three totally different parameters. For some parameters (meteorological fields) the distinction between category and parameter is artificial, because the surface type is fixed and there is usually no statistical process applied, e.g. Total precipitation, Snow melt. In such cases one can just use the word parameter.

Instantaneous parameters (meteorological fields) are defined by nine values:

- Discipline (specified in GRIB Section 0),
- Category (specified in GRIB Section 4),
- Parameter number (specified in GRIB Section 4),
- Type of first fixed surface (e.g. mean sea level, isobaric surface),
- Scale factor of first fixed surface,
- Scaled value of first fixed surface,
- Type of second fixed surface (e.g. isobaric surface, specific height level above ground),
- Scale factor of second fixed surface,
- Scaled value of second fixed surface.

Parameters, which are defined over a continuous or non-continuous time-interval, need additional pieces of information:

- Applied statistical process (e.g. accumulation, maximum),
- Length over which the statistical process is applied,

e.g. 2m maximum temperature in the last 3 hours or 2m maximum temperature in the last 6 hours.

It is to be noted that a few parameters might have missing entities, e.g. Mean Sea Level Pressure has no second fixed surface and no statistical process is applied.

It is obvious from the organization of the branching structure, that the surface type or the type of statistical process must not be part of the name in Code Table 4.2. Otherwise it would produce confusion. Example: The parameter *Maximum temperature* can be coded in different ways:

> Discipline: 0, Category: 0, Number: 0 (Temperature), statistical process: 2 (Maximum)
> Discipline: 0, Category: 0, Number: 4 (Maximum temperature), statistical process: 2 (Maximum)
> Discipline: 0, Category: 0, Number: 4 (Maximum temperature), statistical process: 255 (Missing, because it is already part of the parameter number 4)

Similar situations appear when the surface type becomes part of the Code table 4.2. Example: Soil temperature (Product Discipline 2) exists in Category 0 (Vegetation/Biomass) and with a not well-defined surface type in Category 3 (Soil Products).

The Team agreed with ECMWF that:

It is against the philosophy of GRIB 2 if the surface type and/or the statistical process become part of the names in code table 4.2.
It creates ambiguities
It fills Code Table 4.2 unnecessarily fast up and hence makes GRIB 2 too complex.

The Meeting agreed to add parameter numbers and to mark parameters as deprecated; and to address the special case of precipitation. The Meeting agreed that these new parameters would resolve a vast number of confusion while coding and reduce the number of entries in Code Table 4.2 without loosing any benefit. Information about the statistical process, surface types and layer-types should not be part of the names in Code Table 4.2.

The Annex to this paragraph describes the renaming to be performed.

2.2.5.2 Simple packing with logarithm pre-processing

ECMWF noted that there was a problem using simple packing for fields containing grid point values within very large range. That will be the case with chemicals and aerosol fields. The Meeting agreed for a new template, which can be used in such cases as listed in Annex to this paragraph.

2.3 REPORT ON EXPERIMENTAL AND OPERATIONAL EXCHANGES OF FIELDS IN GRIB2

2.3.1 ECMWF has been progressing with the GRIB2 definitions for most of the TIGGE parameters and has created a web site containing sample encodings:

http://tigge.ecmwf.int/tigge/d/show_archive/table=parameters/

2.3.2 Use of GRIB2 in the USA

Mr Jeff Ator reported to the group that the use of GRIB2 within the U.S.A. has expanded considerably since June 2004. At that time, NCEP was providing half-degree output from its global model to the U.S. Air Force Weather Agency (AFWA) using GRIB2. Now, NCEP also provides output from both its global and mesoscale models to the U.S. National Weather Service (NWS) on the NOAAPORT satellite system. These GRIB2 products are at the highest spatial resolutions available from these models and will be utilized within the NWS as a replacement for the older, lower resolution GRIB1 products in the near future. In addition, GRIB2 products from NCEP's ocean models are also expected to become available beginning in late 2006.

In June 2006, NCEP is planning to begin a transition to GRIB2 for all of its GRIB1 content on the NCEP and NWS public ftp servers. For all of its existing GRIB1 public products, NCEP will make available both a GRIB1 and GRIB2 formatted set of products for a minimum of six months. During this time users will be encouraged to migrate to the GRIB2 products. After the six-month transition period, all GRIB1 format products will be removed from the public servers. To help facilitate users' migrations, NCEP has made available its GRIB2 software and libraries (including a routine to easily convert between the GRIB1 and GRIB2 formats) on its public web server.

2.3.3 Planned use of GRIB 2 in China

Ms Fang Zhao reported as for TIGGE, the Ensemble Prediction (EP) output and products of Beijing 2008 Olympics Mesoscale Ensemble Prediction Project (B08RDP) would be collected, disseminated and distributed in GRIB2 within CMA. The EP model output would have to be interpolated into regular latitude/longitude grid fields specified by CMA (domain, resolution, etc). One GRIB2 message file contains one EPS member output, with 6 parameters and every 3 hour output from 0~36 hour. The NCEP decoding/encoding software of GRIB2 was downloaded and studied. The EPS model output of CMA has already been encoded/decoded in GRIB2 using NCEP software and are available for experimentally exchange. Ms Fang Zhao reported difficulties because there was little experience in using GRIB2, especially for the metadata definition for ensemble data and that clear guidelines would be needed to explain how all B08RDP fields should be coded in GRIB2. Furthermore, the existing data analysis and visualization tools have to be developed to handle GRIB2.

The Meeting encouraged China for this endeavor and recommended that there was indeed a need to review the GRIB 2 guide and in particular to explain how to deal with ensemble data.

3. BUFR AND CREX

3.1 REVIEW OF ENTRIES AWAITING VALIDATION FOR BECOMING PRE-OPERATIONAL

3.1.1 The Team considered the present list of Table entries awaiting validation. It was considered that the descriptors for regional practices, including nominal value indicator 0 08 083, as well as for SIGMET representation could be considered as pre-operational. The VOS observation descriptors and for radiation will remain for validation. The remaining entries for validation are listed in Annex to this paragraph.

3.1.2 The final proposal for SIGMET transmission in BUFR, as in Annex to this paragraph was declared pre-operational.

3.2 NEW DESCRIPTORS FOR AIR CHEMISTRY

3.2.1 The Team considered the second phase of the proposal submitted by Yves Pelletier and Yves Rochon from Canada, from ECMWF and from USA. The proposal intends to provide a framework suitable for the reporting and forecasting of atmospheric constituents in disciplines related to Atmospheric Chemistry. This was initially in response to observational data representation requirements expressed by the Canadian research community, but there were shows of interest from ECMWF, the US NWS and others. The aim was to help meet similar needs in the international community, as described in the 2004 IGACO theme team report. It was also foreseen a need for the exchange of data in an emerging international population of atmospheric chemistry prediction models.

Scope of this proposal
There was a lot of ground to cover in order to produce a comprehensive depiction of atmospheric chemistry concepts in BUFR. It seemed prudent, then, not to try to do it all at once. A firm base should be established and validated before building toward more complex themes. The first phase contained proposals toward the following topics:

- The cataloguing of chemical species
- Descriptors for basic quantities or physical attributes in the discipline of Atmospheric Chemistry
- Basic descriptor sequences

This proposal expands on the initial topics and adds the following:

- Representation of more complex species, such as particulate matter
- Representation of averaging kernels and correlation matrices
- Further elements in the discussion on floating point data representation

Approaches to satisfy precision requirements

3.2.1.1 The absolute values and precision required for some measurement types (i.e. concentration) span across at least 16 decimal orders of magnitude with different chemical species covering very different dynamical ranges. This means that a concentration descriptor meant for general use for any chemical would need to be at least 54 bits wide. For individual species, the required width could in some cases exceed 32 bits.

Out of the five solutions proposed to the meeting, two options were chosen for closer examination.

Option (i): adding an IEEE floating point Data Description Operator, was discussed in considerable detail during the plenary session. The meeting acknowledged the importance of providing the atmospheric chemistry community with a BUFR framework that met its requirements. However, it was felt that the repercussions on existing software of adding a new IEEE data operator were too considerable to go ahead within the scope of the current BUFR edition. There was agreement to examine options for including IEEE representation in the next BUFR edition.

Option (ii): as a means to provide functionality to represent wide numerical dynamic ranges within the current BUFR edition, the Team agreed to this solution: a new element descriptor, 0 08 090), named "decimal scale" is defined. This 8-bit wide descriptor will be used to set a decimal scale applying to one or more subsequent numerical element descriptors. The eight bits allocated to the scale descriptor cover the range from 10^{-126} to 10^{127}, with the value -127 (all ones) being reserved to cancel the decimal scale descriptor. This provides the same dynamic range as 32-bit IEEE.

To implement this approach, descriptors requiring a large dynamic range, such as concentration or mixing ratio, will contain a scaled value of the measurement. The actual value will be obtained at the application level by multiplying the scaled value by the decimal scale given by descriptor 0 08 090 (scaled value * $10^{\text{decimal scale}}$). The BUFR sub-group provisionally allocated 10 bits to the scaled value descriptors, which is sufficient to achieve four significant digits precision. The scientific community will be consulted to determine if this meets precision requirements for scaled values. By way of comparison, a scaled, signed value of 24 bits would achieve nearly 7 significant digits, providing the same precision as 32-bit IEEE.

Averaging Kernel and Covariance Matrix Representation

3.2.1.2 The Team considered the representation of matrices in BUFR. The approach proposed is accepted as an initial idea but there are other possibilities to be explored. The optimal structure of matrix templates will depend to some extent on the variability of the dimensions of the matrices to be exchanged. This requirement is yet to be fully determined. The requested new descriptors for matrix representation were accepted for validation, and two new descriptors were added for matrix dimensions. The sub-group agreed that suggested templates for the representation of matrices should be developed to assist users with this type of data representation need. It was noted that the matrix representation being requested is not strictly speaking an atmospheric chemistry requirement, but rather an application of more general data assimilation principles.

Representation of Particulate Matter

3.2.1.3 The initial proposal made possible a simple representation of particulate matter, by using size as the only characterization of a PM population. In this way it was possible, for instance, to treat "PM < 2.5" as a generic chemical species in table 0 08 043.

The problem to be resolved is how to associate an ion species to the volumetric mass measurement for a PM population under a given size. There are two ways to do this in the framework of the updated proposal : one could add one new significance qualifier and associated table to represent the various ions, or add entries to table 0 08 043. The Meeting recommended using a new significance qualifier. Therefore a descriptor 0 08 045 "Particulate matter characterization" was defined (for validation). This element descriptor is a code table that can be used to specify a subset of a particulate matter population on the basis of ion composition.

Descriptors for the representation of atmospheric constituents

3.2.1.4 Most of the discussion regarding specific descriptors took place at the Muscat meeting, so there were few comments at the Montreal meeting. One question was raised regarding descriptor 0 20 080, which expresses cloud amounts in percentage intervals. The meeting requested ECMWF to clarify whether the cloud amount could be expressed directly in percentage.

3.2.1.5 The Team agreed that the descriptors as listed in Annex to this paragraph would remain for validation. However the Team recommended that this should be undertaken rapidly since the demand for encoding this data was starting with modelling of atmospheric chemistry and air quality.

3.2.2 Following a request in 2005 for encoding concentration of pollutant, the corresponding descriptor (see Annex to this paragraph) was declared pre-operational.

3.3 REQUIREMENTS FOR GTS DISTRIBUTION OF OCEAN DATA

3.3.1 The Secretariat reported that the JCOMM Ship Observations Team (SOT) is working on the issue of data in BUFR format and is presently considering a large number of requirements.
Proposals for new SHIP (VOS and VOSClim), XBT/XCTD, and TRACKOB templates are being defined and will eventually be proposed. The following requirements are being considered:
Requirements for the GODAE High Resolution SST Pilot Project (GHRSST)
VOSClim requirements (metadata and quality information flags)
META-T Pilot Project (metadata of category 1 required for real-time exchange)
XBT/XCTD requirements
Consistency between templates XBT/XCTD and Argo templates (both providing sub-surface temperature profiles)
Consistency between VOS and TRACKOB
Consistency between all ship templates as far as metadata

3.3.2 Only the requirements for the GHRSST were proposed at this meeting. The GHRSST requires the GTS distribution of SST temperature type/method of measurement as well as the depth of measurement below the sea surface. As the VOS SHIP template will completely be redefined, it is not proposed to substantially change it now. Only the following modifications related to (i) B/C10 – Regulations for reporting SHIP data in TDCF – and (ii) to the BUFR template for synoptic reports from sea stations suitable for VOS observation data are being proposed as pre-operational (see Annex to this paragraph):

- New entries in code table 0 02 038 “Method of water temperature and/or salinity measurement” to deal with additional methods such as infrared radiometer, in line thermosalinograph, and towed body (see Annex part I).
- New descriptor 0 07 063 Depth below sea water surface (High resolution) to provide for higher resolution of depth (scale=2, i.e. 1cm) (see Annex part II)
- Change sequence 3 02 056 for adding descriptor 0 07 063 for indicating water temperature depth see Annex part III). So the sequence 3 02 056 (comprised of 0 02 038 “Method of sea surface temperature measurement” and 0 22 043 “Sea/water temperature”) in the templates should be replaced by the new one.

3.3.3 The Meeting was informed that the JCOMM Data Management Coordination Group will meet in Geneva, 2-4 October 2006. This group will discuss, in particular, what mechanisms could be put in place to regularly review and update BUFR Master Table 10 for oceanographic data. It is also proposed to use the Master Table 10 as a Pilot Project for the real-time distribution of ship data produced by SeaKeepers. GHRSST requirements will be taken into account in this Pilot Project.

3.4 VARIOUS NEEDED ADDITIONS OR CORRECTIONS

3.4.1 Number for operational and pre-operational tables

For GRIB Master Table Version Number, the ET/DR&C in Oman noted that there were two problems to be discussed:

a) Specifying pre-operational version number of GRIB Master Table, which virtually contained pre-operational entries.
b) Necessity of implementation date for each operational version number.

The necessity of pre-operational version numbers was clear, because:

a) Actually, a lot of "pre-operational data and products" containing pre-operational descriptors were exchanged internationally via the GTS or the Internet and exchange of pre-operational data and products was *officially* permitted.
b) For archiving purpose, pre-operational data were exactly like operational ones, and were expected to be declared fully operational at the next operational implementation so the number of the version of the table should correspond to the next operational version number. The Team agreed to this solution.

The ET/DR&C in Oman agreed that the system of table numbers defined for GRIB 2 was also appropriate for BUFR.

The Team agreed to create entries in Class 0 as listed in Annex to this paragraph. These additions will allow full exchange of Master Table in BUFR. The Octets description for Section 1 should also be modified accordingly.

3.4.2 Additional entries for polar satellite data

Data from AMSU-A, MHS, HIRS, IASI, GRAS and ASCAT will be exchanged in BUFR when available. In order to represent data from the new instruments, new BUFR element descriptors, sequence descriptors, and code and flag table entries, proposed by Dr Simon Elliott from EUMETSAT last year were reviewed after some refinements and were approved for pre-operational status (see Annex to this paragraph).

3.4.3 Pre-operational entries of BUFR Tables D for new templates of RADOB, TRACKOB and SAREP

At the previous meeting of the Expert Team on Data representation and Codes (ET-DR&C), held in Muscat, Oman, from 5 to 8 December 2005, the table D descriptors for RADOB (part A), TRACKOB and SAREP (part A) data in BUFR proposed by the Japan Meteorological Agency (JMA) were approved for validation. Validation tests for these table D descriptors had been carried out by the European Centre for Medium-range Weather Forecast (ECMWF) and JMA with sample BUFR data produced by JMA. The result of the test showed that no problem was found in those descriptors. The meeting recommended these descriptors (see Annex to this paragraph) for pre-operational status with a view to submitting them to the next session of the Commission for Basic Systems (CBS).

3.4.4 Additions in CREX for sea level data monitoring (Tsunami warning programme)

The ET-DR&C has been asked to provide guidance on encoding tide gauge data in CREX for Tsunami warning purposes. A preliminary list of requirements and copies of some email exchanges were supplied to the meeting. Further emails and documents were received following a meeting of the ICG/PTWS and ICG/IOTWS in Melbourne between 01 May and 02 May 2006. One of these was a revised list of requirements for the exchange of sea level data for Tsunami warning purposes. A stated aim of the ICG/PTWS and ICG/IOTWS was to have a document ready for the ET-DR&C by June 2006.

The specified requirements require some additional details before a CREX template can be developed. In particular, the valid ranges and required resolution for many data elements are not sufficiently well defined yet. The likely number of entries in m any code tables, needed to define the data width, are also unclear.

The meeting recommended that Charles Sanders, Dr Eva Červená and Atsushi Shimazaki contact representatives of the ICG/PTWS and ICG/IOTWS to obtain the required additional information. The aim will be to create a CREX template for the exchange of sea level data for tsunami warning purposes by June 2006, ready for validation.

3.4.5 Other requested additions or modifications to the BUFR/CREX table

3.4.5.1 AWS BUFR representation of nominal values

The Team appreciated the work carried out by Milan Dragosavac to represent the nominal value in BUFR. BUFR format already contains a mechanism to represent quality control, first order statistics, departures, replaced/retained values and substituted values. The usage is defined by selection of the appropriate BUFR Table C operators. <u>It has to be stressed that although CREX is very similar to BUFR, it does not support representation of those features.</u> The proposed descriptor (declared preoperational) allows reporting of Level II data (meteorological parameters, nominal values) in addition to Level I data (instrument values) in BUFR templates for surface observation data, especially for data from Automatic Weather Stations. In the Annex to this paragraph the descriptor needed and the way of representing nominal value are described. The proposed solution is fully universal and is capable of representing nominal value regardless of the number of elements for which the nominal values are required. According to the proposed method the representative heights of sensors as well as the nominal values will be reported as substituted values.

3.4.5.2 Proposal for miscellaneous additions and corrections in BUFR/CREX Table B
During the process of writing Regulations for reporting TAC data in TDCF, Dr Eva Červená identified some points that would need clarification. The proposals for miscellaneous corrections and additions to existing BUFR/CREX descriptors (see Annex to this paragraph) were agreed by the Team and were to be treated as editorial.

3.4.5.3 New Descriptors for GHRSST data

The Global Ocean Data Assimilation Experiment (GODAE) high-resolution sea surface temperature pilot project (GHRSST-PP) provides a new generation of global high-resolution (<10km) SST data products to the operational oceanographic, meteorological, climate and general scientific community, in near real time and delayed mode. The project involves a wide range of international participants who have invested a great deal in delivering high quality SST products. There is a requirement to exchange GHRSST data between operational centers in a WMO standard format. Although the GHRSST standard product is delivered in NetCDF, and is being converted to BUFR at the U.K. Met Office for operational use, UKMO indicated that this necessitated the use of suitable descriptors for the exchange of this data. A set of requested descriptors and codes and flag tables is listed in Annex to this paragraph. The Team considered that this proposal needed some refinements to be given entries for validation, for example: it was suggested to use 2 25 operator for difference. Some abbreviations need explanation. Tables 2, 3 and 4 need to be presented in a manner according to BUFR standard (include extra bits for All missing, reorder from 1 to 9, remove GHRSST column). It recommended making a review by email within the Expert Team.

3.4.5.4 Requirements for Data from Automatic Weather Stations

During the session of the Expert Team on Requirements for Data from Automatic Weather Stations (ET-AWS) which was held in Geneva from 20 to 24 March 2006, the representative of EUMETNET pointed out problems that would arise in the generation of BUFR messages from some NMSs, due to the existence of different WMO BUFR templates, in particular: AWS BUFR template for one hour and SYNOP BUFR template. No guidance has been provided as to which WMO BUFR template should be used. Therefore, this could lead to difficulties and/or delays in migration to TDCF. The representative of EUMETNET presented a proposal for a BUFR template, blending the current AWS and SYNOP BUFR templates (see Annex to this paragraph). The Meeting considered that this template needed review and Dr Eva Červená accepted to contact the producers of this template to fix with them the points needing improvements.

The Meeting recognized that there was a recommended set of templates to convert traditional observations into BUFR. These templates were recommended but not mandatory. What was mandatory was the set of essential parameters, which must be exchanged between countries. BUFR allows some flexibility by definition. The Meeting accepted the possibility of different templates, but warned that a proliferation of such templates should not be a good idea, although BUFR decoders will be able to extract fully the required parameters for the applications.

The Meeting noted that the proposal of two new descriptors needed some refinements to be accepted for validation. In particular, the proposal of the Quality control indicator might be reconsidered. The Meeting recommended making a review by e-mail between the ET-AWS and ET-DR&C.

4. MODIFICATIONS TO AVIATION CODES

4.1 NEW MODIFICATIONS TO AERONAUTICAL CODES

4.1.1 ICAO proposals for changes to the aeronautical codes for METAR (FM 15), SPECI (FM 16) and TAF (FM 51)

Proposed changes to the aeronautical codes for METAR (FM 15), SPECI (FM 16) and TAF (FM 51) were presented by ICAO (see Annex to this paragraph). These were given as advanced notice of the most likely changes to the requirements. These proposals were consequential to draft Amendment 74 to ICAO Annex 3/WMO Technical Regulations [C.3.1], which were subject to consultation with States and, if adopted by the ICAO Council, will become applicable on 7 November 2007. These changes include the elimination of the use of SKC and the separation of present weather elements into groups with and without a requirement to report or forecast a change in intensity. These changes concern both observations and forecasts. A significant change is made in TAF for the introduction of TAF covering a 30-hour period. All time groups, including those for change groups will require the date and time (as opposed to simply the time in the current table). Additional changes to the notes in the *Manual on Codes* (WMO No. 306) are also suggested in line with the proposed changes to the requirements in Annex 3/Technical Regulations [C.3.1]. It is also suggested, that references to national practices be not included in the notes to avoid the potential for misunderstanding bearing in mind that such practices are filed as differences to the international requirements and covered in the part related to national practices. The Team had no objection to these proposals with the exception that the Czech Republic objected to the change of encoding runway designator in the State of runway group (R_RR_R to RD_RD_R). If this change were to be implemented, however, it should be reflected not only in the Code Form, but also in Regulations 15.13, 15.13.6 and 15.13.6.1, which should be modified accordingly. The rest of the Team recommended the changes to the aeronautical codes for METAR (FM 15), SPECI (FM 16) and TAF (FM 51) for CBS endorsement in November 2006. The planned date for implementation is 7 November 2007. ICAO indicated that countries are being consulted for these changes on the ICAO side and that the Air Navigation Commission will review the results of the consultation before the end of October.

During the last meeting of the ET/DR&C in Oman, last year, Mr Charles Sanders (Australia) reported that he had compared the definitions of METAR, SPECI and TAF in the ICAO documentation (Annex 3 to the Convention on International Civil Aviation) and the definitions of the same codes forms in the WMO documentation (WMO publication 306, Manual on Codes). Several differences were noticed. Of particular concern, the TAF code form did not correspond to the TAF template in Annexe 3. The meeting decided not to change the codes manual at the next possible date (November 2006), but to combine the corrections with those required for Amendment 74 of Annexe 3, to become applicable in November 2007. The proposed amendments to Volume 1.1 are contained in the appendix to this paragraph.

4.1.2 Proposed changes to SIGMET

Draft Amendment 74 to Annex 3/WMO Technical Regulations C.3.1 also contains proposals to change the requirements for SIGMET which would influence the code tables for representation of SIGMET in BUFR being created by the group. Some details concerning the description of the geographical position of hazardous phenomena are proposed to be added or modified and perhaps the most significant is the deletion of the outlook in SIGMET for volcanic ash and tropical cyclones. The proposed changes are shown in Annex to this paragraph and would have to be included for operational implementation on 7 November 2007.

4.1.3 Requirement to develop the GRIB2 Code Form

It is expected that a requirement will be developed for forecasts of icing, turbulence and convective cloud for issuance by the two World Area Forecast Centres (WAFC) which would require the use of

GRIB2 in this respect as no additional elements are possible in GRIB1. This requirement would be expected to become applicable in November 2010. The Team noted that the use of GRIB 1 for the user of aviation products should be extended to November 2010, because necessary equipment and software for GRIB 2 will not be available in all countries by November 2008.

4.2 IMPLEMENTATION CALENDAR FOR CHANGES TO AERONAUTICAL CODES

In the last Meeting in Oman the WMO Secretariat pointed to the Team that the biennial regular sessions of CBS imposed constraints on the dates where changes to aeronautical codes (FM 15 METAR/SPECI AND FM 51 TAF) could be implemented. The Team agreed that there was a need of respecting an agreed calendar and that the adaptation of ICAO of this calendar for the changes to codes was imperative. The WMO systems were more and more automated and sufficient delay were required to plan the related software changes, the development and testing. The planned dates for approval of code changes and implementation for the next 4 years are listed in Annex to this paragraph.

The Team, together with the representatives of the ICAO Secretariat, strongly recommended to CBS, CAeM and ICAO to ensure the coordination of dates of implementation by WMO of code changes with the dates of implementation of amendments to Annex 3/WMO Technical Regulations C.3.1.

4.3 REPORTING CLOUDS OF OPERATIONAL SIGNIFICANCE IN METAR AND SPECI

Dr Eva Červená pointed to the Team that the reporting of clouds is specified in Annex 3 to the Convention on International Civil Aviation [1], Chapter 4, as follows:

> *4.6.5.1 Cloud amount, cloud type and height of cloud base shall be observed, and reported as necessary to describe the clouds of operational significance. When the sky is ...*

In Manual on Codes, WMO-No. 306, Volume I.1 [2], on the other hand, there is no regulation that would indicate that only clouds of operational significance should be reported. Reporting practices with regard to cloudiness therefore differ if either the specification in [1] or in [2] is considered as relevant. The Team agreed to propose to modify Regulation 15.9.1.1 in the Manual on Codes, WMO-No. 306, Volume I.1 in such a way that the existing text of this regulation would be preceded by the first sentence of Regulation 4.6.5.1 [1] (see Annex to this paragraph).

4.4 REPORTING CUMULONIMBUS CLOUDS IN METAR AND SYNOP AND TOWERING CUMULUS CLOUDS IN SYNOP

i). Reporting Cumulonimbus clouds in METAR and SYNOP if a thunderstorm is in progress

The Team considered that to solve the above problem a proposal should come from a country through ICAO and that it was to the AMOS study group to formulate first the requirement for change in METAR.
The Team considered that the problem has inter-OPAG or even inter-Commission character and should be dealt with by CBS/IOS, CIMO or CAeM experts rather than by CBS/ISS/ET-DR&C experts.

ii) Reporting Towering Cumulus clouds in SYNOP

The Meeting was informed also about the problem of observed less than 3 octas of towering Cumulus, which cannot be reported in SYNOP according to the present regulation.

5. MANUAL ON CODES IN RELATION TO MIGRATION TO TABLE DRIVEN CODE FORMS

5.1 PROPOSED OBSERVATIONS REPORTING PRACTICES FOR TDCF IN MANUAL ON CODES

A proposed set of regulations for reporting TAC data in BUFR or CREX, developed by Dr Eva Červená was reviewed by the Meeting. The Meeting recommended they be finalized for the OPAG-ISS meeting in September 2006 and proposed for inclusion in the Manual on Codes. The Meeting also recommended they be placed on the WMO web site. The list of regulations is below and is contained in full in the Appendix to the final Report.

B/C1 – Regulations for reporting SYNOP data in TDCF,
B/C5 – Regulations for reporting SYNOP MOBIL data in TDCF,
B/C10 – Regulations for reporting SHIP data in TDCF,
B/C20 – Regulations for reporting PILOT, PILOT SHIP and PILOT MOBIL data in TDCF,
B/C25 – Regulations for reporting TEMP, TEMP SHIP and TEMP MOBIL data in TDCF,
B/C26 – Regulations for reporting TEMP DROP data in TDCF,
B/C35 – Regulations for reporting CLIMAT TEMP and CLIMAT TEMP SHIP data in TDCF.

The Meeting wished to thank Dr. Červená for her excellent work. The Meeting also wished to thank Ms. Sibylle Krebber (Germany) and Mr. Jan Willem Noteboom (Netherlands) for their contributions. *(Action: volunteers to verify regulations of one type before September*)

5.2 PROPOSAL FOR COVERAGE OF REGIONAL REPORTING PRACTICES IN BUFR TEMPLATES FOR TAC

The Meeting reviewed proposed BUFR TEMP and TEMP SHIP templates for regional reporting practices submitted by Dr. Eva Červená. No corrective comments or alternative suggestions have been made. Three new descriptors were added to the original proposal presented at the December 2005 ET-DRC meeting held in Oman. Besides that, representation of doubtful temperature and geopotential data has been rewritten using significance qualifier 0 08 040 (see Annex to this paragraph).
It was suggested by the Meeting that these templates should be reviewed and approved by Regional Associations to be included in Volume II of the Manual on Codes.

5.3 PROCEDURAL ISSUES FOR NATIONAL PRACTICES

Representing national practices in TDCF had been considered a procedural issue. The Meeting discussed this further and provides the following guidance for reporting national practices and for “additional data” as defined in Resolution 40.

The Meeting noted that normally data related to national practices were not exchanged internationally. The Meeting determined it was not necessary to develop templates for all countries' national practices and that it was the responsibility of individual countries to do so as their needs warranted. The Meeting decided only regional practices should be in recorded templates. The Meeting wished to point out these data could also be put in separate BUFR messages for exchange. Another approach is to use local descriptors in conjunction with operator 2 06 yyy.

5.3.1 Procedural issues for national reporting practices

a) Coverage of national reporting practices published in the Manual on Codes, Volume II shall be the responsibility of the NMS concerned.
b) Members of the Meeting shall provide advice and suggestions for solving the actual problems, especially to national focal point on code matters.

c) Representation of national procedures may be accomplished by supplementing the existing global or regional BUFR templates by relevant additions, using the entries available in the international portion of BUFR Tables.
d) A regional BUFR template, ifavailable, shall not be mandatory for Member States of the particular Region. Either the global template for the TAC data type or any of the regional templates, whichever is the most convenient, may be used.
e) For international exchange, local descriptors shall be preceded by an operator 2 06 Y.
f) Data, corresponding to the content of national sections in TAC (e.g. Section 5 of SYNOP), shall not be included in BUFR messages for international exchange.
g) If required for the exchange by regional or bilateral arrangements, the complete extent of data, including representation of national sections in TAC, may be included in additional bulletins. These BUFR messages shall be disseminated with limited distribution only.

5.3.2 "Additional data" as defined in Resolution 40 (Cg-XII)

Manual on the GTS, WMO-No.386, Volume I, paragraph 2.3.2.1, the part related to ii specifies selection of ii for "additional" data as defined in Resolution 40 (Cg-XII):

> *Bulletins containing "additional" data as defined in Resolution 40 (Cg-XII) shall be compiled into bulletins with ii above 19. This does not apply to bulletins compiled in BUFR or CREX code.*

The difference between "essential" and "additional" data may be also accomplished by usage of additional CCCCs in the telecommunication header. In case of TAC data, however, "ii" is the prevailingly used tool for differentiating between these two types of data as defined in Resolution 40 (Cg-XII). Even though unique WMO headings can be given to bulletins containing "additional" data, the absence of a corresponding designation of ii usage for TDCF might be perceived as a negative feature in regard to migration to TDCF.

The Meeting recommended the ET-OI reviews this situation and that the Manual on the GTS, WMO-No.386, be updated to specify usage of ii for designation of "additional" data as defined in Resolution 40 (Cg-XII) not only for bulletins compiled in traditional alphanumeric codes, but also for bulletins compiled in GRIB, BUFR or CREX code.

5.4 REVIEW NEEDED TEMPLATES AND COMMON SEQUENCES

5.4.1 All the templates for the following observations in BUFR/CREX have been satisfactorily encoded and decoded by Japan and ECMWF and can be declared pre-operational:

B/C1 – Regulations for reporting SYNOP data in TDCF,
B/C5 – Regulations for reporting SYNOP MOBIL data in TDCF,
B/C10 – Regulations for reporting SHIP data in TDCF,
B/C20 – Regulations for reporting PILOT, PILOT SHIP and PILOT MOBIL data in TDCF,
B/C25 – Regulations for reporting TEMP, TEMP SHIP and TEMP MOBIL data in TDCF,
B/C26 – Regulations for reporting TEMP DROP data in TDCF,

5.4.2 Proposal for modification to BUFR template for CLIMAT TEMP and CLIMAT TEMP SHIP data.

The Meeting reviewed a revised version of BUFR template TM 309054 for CLIMAT TEMP and CLIMAT TEMP SHIP data submitted by Eva Červená (Czech Republic) and recommended adoption of the proposal. The regulatory material B/C35 (Regulations for reporting CLIMAT TEMP and CLIMAT TEMP SHIP data in TDCF) contains the revised version of the BUFR template TM 309054 as shown in the Annex to this paragraph.

5.4.3 Proposed BUFR template for buoy wave data

The Meeting reviewed the proposed descriptors for BUFR template for buoy wave data (to translate WAVEOB in BUFR) and accepted the new attributed sequence number (see Annex to this paragraph). However, since the proposal has not yet been used or tested it should remain " for validation status".

5.4.4 Proposed BUFR template for High Resolution_Radiosonde data

The Meeting reviewed the template for representation of high-resolution_radiosonde data requested by the Upper-air systems Intercomparison Team. This template would be used by manufacturers for production of BUFR information at the observation platform system. The Meeting studied this template and made the comments as listed in Annex to this paragraph.

5.5 REVIEW METAR/SPECI/TAF TEMPLATES AND RELATED BUFR SEQUENCES AND PARAMETERS

The Meeting reviewed the METAR/SPECI/TAF templates and related BUFR sequences and parameters (see Annex to this paragraph) submitted by Charles Sanders (Australia) with major contributions from Eva Červená with a view to submit it to the OPAG on ISS in September for further approval by CBS Ext. 2006, since operational exchanges by bi-lateral agreement could take place from 7 November 2007.
It was noted that the current table D descriptors do not allow all possible aviation aerodrome forecasts to be encoded. New descriptors were proposed for this purpose, together with suggested TAF and METAR templates. The old Table D sequences in the BUFR Manual should be deprecated. The Meeting also stressed that regulations, as well as for the other WMO TAC converted to BUFR/CREX, regulations would have to be developed.

6. REVIEW STATUS OF MIGRATION

6.1 INFORMATION SHARING

Information of the status of the migration in different countries, regions and organizations was shared between the experts.

6.1.1 Some information available at the WMO Secretariat was shown. The Secretariat posts and maintains lists of BUFR and CREX bulletins (excluding radar and satellite data) included in the Volume C1 which are relevant to the migration on its web server. This URL is:
http://www.wmo.int/web/www/ois/Operational_Information/TDCF/Migration_tdcf.html#Table%20C7

BUFR Bulletins are listed only from Hong-Kong, Prague and Tokyo. CREX Bulletins are listed only from Nadi (Fiji) and Prague. The Meeting noted that these tables needed significant updating. There were many more bulletins exchanged in BUFR than what was included in the tables. The Meeting repeated that Countries creating new BUFR bulletins should inform the Secretariat of new bulletins made available on the GTS.
The Secretariat informed that when information was sent to hundred focal points for code matters last year, simple questions regarding the migration were included. However, only few answered (Argentina, Nepal, Norway and Pakistan). The Secretariat mentioned also that there was information that Brazil and Costa Rica were working on the preparation for Migration.

The Meeting concluded that passing more Information about the Migration to all WMO PRs was a necessity. A circular letter with appropriate documentation should be sent. Another questionnaire should be dispatched. More consideration of the subject in constituent body meetings (JCOMM; CCI, AeM, CBS; EC and Congress) would be necessary. Associating RTH focal points for the dissemination of information on migration was also a necessity. The Meeting recommended that the last up to date status information on the migration should be given at the next CBS in November 2006.

6.1.2 Fred Branski provided the following information regarding the migration to table driven code forms.

6.1.2.1 U.S. planning:

The three main agencies in the U.S. involved in Code migration are the National Weather Service (NWS), the Federal Aviation Administration (FAA) and the Department of Defense (DOD). There are several others agencies that are significantly less impacted by code migration. In the U.S. the Office of the Federal Coordinator for Meteorology (OFCM) is the government organization responsible for inter-agency planning and coordination. This organization has a Committee for Environmental Information Systems and Communications (CEISC) under which is the Working Group for Meteorological Codes (WGMC). The WGMC is tasked with developing the U.S. National Plan for Code Migration. There has been discussion of needs during several meetings or teleconferences. Following is a summary of work so far.

BUFR data availability

Limited BUFR is available on the RTH Washington servers. More but not all are exchanged across communication lines including the GTS. This is primarily due to delay in implementation of the Replacement Telecommunication Gateway (RTG). Once the RTG reaches its initial operational capability (IOC), the RTH will undertake to expand availability of BUFR data via all exchange mechanisms. IOC is expected in the next few months. The intent is to make all received BUFR data available on the servers, to further increase production of translated data within the RTH and to expand distribution of BUFR via communications systems.

U.S. National Code Migration Plan

The CEISC and WGMC have considered the international Migration Plan. It should be noted these groups are also looking at the transition from GRIB1 to GRIB2.

<u>GRIB</u>: It was agreed there is a need to identify sources where GRIB is obtained from such as other international centres. This was critical so planning could be done based on plans for all sources of GRIB data.

The FAA provided insight into aviation use of GRIB. There are 3 areas, which use GRIB: the FAA as a whole, the airlines, and the WAFS (e.g., workstations). The National Weather Service' Aviation Weather Center is already transitioning to GRIB2 and as such most FAA internal needs such as at Central Flow Control can handle GRIB2. However, there are still legacy systems in the regional Air Route Traffic Control Centers (ARTCC) and some other places that depend on WAFS and other GRIB1 products. It needs to be further evaluated when they would be able to transition to GRIB2. The second area is the airlines and their access/use of GRIB. The FAA needs to better understand the airlines use of the data. It is believed they will most likely be able to handle GRIB2 but they will also need to be further evaluated. Finally, there is the WAFS itself. Most WAFS workstations are believed to be GRIB2 capable. Work is underway to determine the capability of WAFS workstations for, GRIB2, and BUFR.

For the DOD, there are two issues, the production of DOD products and the ingest and use of data from other producers. The Air Force Weather Agency (AFWA) and U.S. Army have systems which produce their own models and grids. There are no plans at this time for changing these systems. This will need to be evaluated in the future. AFWA uses both the NCEP GFS and NOGAPS models in GRIB1. The DOD is working to identify any dependency on GRIB1 with a characterization on how long that dependency will last.

The NWS is moving forward quickly with its transition to GRIB2. NWS Forecast Office software is being upgraded to handle GRIB2. Within this year, NCEP will be generating all non-aviation products in GRIB2. Where needed, these products will be converted to GRIB1 at RTH Washington for dissemination. Both product sets will be available on the GTS, but we will only disseminate those GRIB1 products for which there is a stated need. This dual dissemination will be done for a limited time

BUFR: There is still much coordination and planning to do for the migration to BUFR.

The FAA has said they will meet any international requirements approved through ICAO. Because of the extensive number of legacy systems, they believe the main methodology will consist of conversion of the code forms especially for international dissemination. There is a new national aviation plan under development and it is planned to tackle BUFR migration within this plan.

The DOD stated their systems should be able to handle BUFR data. They are not yet planning to encode data they originate into BUFR.

NWS forecast offices have limited ability to decode BUFR data today. They currently utilize TEMP/PILOT, aircraft reports and satellite data in BUFR format. Expanding the capability to other formats is only just beginning.

Other agency considerations: Other U.S. agencies also are impacted by migration but to a significantly lesser extent. The National Environmental Satellite Data and Information Service (NESDIS) provides much if not most of its data in BUFR. The Environmental Protection Agency (EPA) produces ozone observation in BUFR. Many mesonet systems operated by federal or state agencies are using or planning to use BUFR. NASA and other agencies also have some experience with BUFR. The OFCM is working to evaluate impacts to and provide coordination with these other agencies. It is not anticipated this will be a serious problem and any problems identified will be able to be resolved through the main migration evolution.

Commercial organization considerations: There are three areas of concern here. They are the production of data primarily affecting hydrometeorological equipment manufacturers, decoding and display of data in workstations and other user interface systems affecting mainly the manufacturers of these systems and lastly weather service providers who have the same issues as government weather services and which include decode, manipulation and encoding of data and products. Generally, it is believed the commercial sector is able to adapt to migration in a timelier manner as long as there is economic incentive.

Summary:

Although there are significant existing capabilities in place to support migration, there is considerable work and coordination yet to be done. This work needs to be captured into a National Plan and implementation coordination methods better organized. The CEISC and WGMC groups are continuing their work with the aim of having plans in draft form by the end of the year (Fred Branski and Jeff Ator are responsible for that).

6.1.2.2 RA-IV considerations:

The makeup of RA-IV makes resolution of U.S. migration approaches critical to developing a regional plan. WMC Washington and MSC (Canada) operate the two major NWP Centres and provide most of the observational data in the region. However, there are many other observations available from other countries in the region are they also have a growing need to process regional and extra-regional data sets. The RMTN in RA-IV is primarily implemented via a satellite based distribution system. The workstations in use within the region are BUFR capable and limited data is being exchanged today. BUFR encoded radiosonde data is being sent on the RMTN with some exploratory use other than in Canada and the U.S. Dr Eva Červená indicated that Mexico had tested with her SYNOP, TEMP, CLIMAT and CLIMAT TEMP data encoded in BUFR.

RA-IV is discussing a Migration Implementation Project, which may incur in conjunction with a pilot project to upgrade communications in the southern area of RA-IV. Much work has yet to be done including development of a regional plan.

6.1.3 Milan Dragosavac (ECMWF) provided information on the reception of BUFR data at ECMWF. The start of the migration of observations from Migration Plan Category 1 observations for operational exchange happened on the 1st November 2005. Japan, Czech Republic, Israel and Netherlands have to be congratulated for their efforts to meet the target date and start the data insertion on GTS. As it is seen from the global data coverage charts (see Annex to this paragraph), only few countries started operational exchange of BUFR data.

The Meeting was informed that ECMWF BUFR and CREX software has been upgraded to handle multi subset messages using different delayed replications. The software can be downloaded as version 000300 from ECMWF web site:

http://www.ecmwf.int/products/data/software/

ECMWF is also developing Java based API to view and create BUFR/CREX data which will be free software as BUFR and CREX.

6.1.4 Information from CMA

6.1.4.1 Ms Fang Zhao from China Meteorological Administration gave information on the reception of BUFR data from Japan Meteorological Agency at CMA (see Annex to this paragraph). RTH Beijing begins to collect BUFR observations of JMA after they were operationally disseminated in November 2005. SYNOP, TEMP and SHIP data (all using WMO standard templates) were decoded successfully. The following work is planned:

(1) The remnant BUFR messages would be decoded.
(2) The comparison of TAC and BUFR observation elements would be implemented.
(3) The BUFR messages (bulletins, reports and elements) would be stored in MDSS (national Meteorological Data Storage System) of CMA.

6.1.4.2 Ms Fang Zhao reported also on the status of cloud-motion-winds data of FY-2C satellite disseminated on GTS in BUFR. The cloud-motion-winds product of FY-2C satellite has been encoded in BUFR and experimentally disseminated on GTS since November 2005. It is the first and the only BUFR message created and distributed by CMA. The data are presently sent to Offenbach, Tokyo, Ulan Bator, Seoul and Hong Kong (see Annex to this paragraph). The following next work is planned:

(1) The quality control of the data would be studied and implemented.
(2) The template would be transferred to WMO standard template D310014, following with quality control information when they are available.
(3) The data compression would be implemented to reduce the volume of the data.

6.1.4.3 Ms Fang Zhao informed the Meeting on the development of a National Migration Plan by CMA (see Annex to this paragraph). She stressed that the Code Tables in the WMO web site should be really up to date; that is absolutely needed to facilitate the development work for the migration process. The difficulty in CMA is that the number of offices to be involved nationally for the migration is huge. It is not foreseen to use CREX since most of the offices are or will be automated. CMA will put SYNOP BUFR data on GTS in 2007 with the main WMO template.

6.1.5 Mr Jeff Ator form USA reported to the Meeting the status of the Radiosonde Replacement System (RRS) program within the U.S.A. The Radiosonde Replacement System (RRS) program is a nationwide effort within the U.S.A. to modernize its aging radiosonde observational infrastructure.

The new system uses instruments with GPS transmitters and a state-of-the-art ground tracking system to produce high-resolution vertical ascent profiles. More information may be found at:

http://www.nws.noaa.gov/ops2/ops24/rrs.htm as well as at:

http://www.ua.nws.noaa.gov/rrs_overview.htm

The program recently completed a lengthy test and evaluation period and is now undergoing systematic deployment at observing sites throughout the country. Eight sites are currently operating using RRS, and the current schedule calls for one new site to be upgraded every 2 weeks until the entire nationwide network has been fully replaced. Under RRS, the usual TEMP and PILOT observations are being disseminated via GTS, albeit with a noticeable increase in the number of significant levels reported in Parts B and D of these code forms. The high-resolution data is available in BUFR format, using standard descriptors approved in recent years by WMO through the ET/DR+C. The BUFR data is not yet being disseminated globally via GTS or otherwise, but plans are underway for this to occur in the future. For now, interested users may obtain such data via ftp from http://www1.ncdc.noaa.gov/pub/data/ua/RRS/NCEP/ in the form of .zip archives, where the contents include the BUFR data as file “Bxxx”, and where “xxx” indicates the ascension number for the current year (See Annex to this paragraph for sequences contained in the RRS BUFR report).

6.1.6 Dr Weiqing Qu (Australia) reported on the operational dissemination of SYNOP bulletins for Australia and Papua New Guinea. WMC Melbourne started operational dissemination of SYNOP bulletins for Australia and Papua New Guinea on 4 May 2006. The product identification is given in Annex to this paragraph.

6.1.7 Mr Waldenio Gambi de Almeida of CPTEC/INPE provided some information on implementation of the migration to table driven code forms in Brazil. Brazil is currently working on a national migration plan (see Annex to this paragraph).

6.1.8 Mr Jan Willem Noteboom from Netherlands reported on the current migration status at KNMI.

6.1.8.1 Since the CT-MTDCF meeting in Geneva in November 2005, there have been substantial progress made in migrating of the KNMI infrastructure. Upgraded retrieval/usage and storage systems are all in the acceptance phase. The production of radiosonde BUFR messages (TEMP) still need some rework resulting from verification remarks by Eva Červená. An upgrade of our measurement network to include the production of BUFR synoptical messages (next to TACs messages) has been delivered recently and is under testing. Also the compilation of BUFR messages has been implemented but needs further testing. The start of operational exchange of Category 1 messages is still planned for November 2006

6.1.8.2 Migration experiences gained:

A) During the implementation of migration at KNMI some experiences have been gained which are worth to be shared:

- migration is more than just installing a BUFR encoder/decoder; integration of such tool in the (operational) data processing chain of activities is the real challenge;
- migration is not translating TACs to BUFR messages;
- well-organized table & template & tooling management is crucial for operational exchange of data;
- validation abilities for BUFR data are limited;
- reporting practices by Eva Červená have been very useful;
- integration of ECMWF BUFR tooling can be problematic (Fortran). Alternative open source up to date of encoding/decoding tooling (edition 3&4) in C or Java has not been found.
- one has
    - to ensure that new (development) projects comply with the migrated infrastructure;

- o to cooperate with other NMCs as much as possible;
  - o to make sure that BUFR templates are sufficiently configurable within upgraded production systems (templates tend to change frequently);
- frequent and adequate communication of the migration activities (internally & externally) helps the migration acceptance;
- XML might be an attractive alternative but will not make things easier.

B) To establish TDCF migrated data dissemination, most NMSs need to upgrade their internal data production infrastructure. To test the upgraded infrastructure, validation by one or more receiving NMSs is in most cases required to ensure that the data can be decoded and that the contents are correct. This way of working requires a person at the receiving NMS who has the time and skills to perform such validation. Such practice works fine well when the amount of requests is limited and sufficient (well-known) experts are available at various NMSes. To migrate to TDCF on a worldwide scale, this kind of validation practice might be inadequate. Additional ways to validate migrate data should be considered to facilitate the TDCF migration better. This expresses the need for an automated centrally organized BUFR/CREX validation service accessible via internet (see chapter 7.1.3).

6.2 REVIEW OF STATUS AND SCHEDULE REGARDING THE MIGRATION TO TABLE DRIVEN CODE FORMS

6.2.1 There have been multiple discussions regarding updates to the Code Migration Schedule. There have also been multiple efforts globally, regionally and nationally to identify current code usage and future plans. These have pointed out the need for a status update.

SATOB Status: During the multi-lateral North American Europe Data Exchange Meeting held last week discussions were held whether there is any further need for TAC encoded SATOB data. It was felt there was no requirement within the major centres. However, there may be some use of the data, which is still being disseminated. In particular, EUMETSAT felt it may still have some users, especially in RA-I. In any case, the Meeting wished to stress to WMO members that SATOB migration is scheduled to be complete by the end of 2006.

Designation of TAC codes as obsolete: The Meeting discussed this issue and considered that Category 6 is currently defined as “almost obsolete”. It agreed to rename this category as “obsolete” and add another footnote indicating they may be used for national purposes or by bilateral agreement but will no longer be maintained by WMO as an active code.

The Meeting agreed that the use of a data format nationally or for bilaterally agreed purposes is independent of WMO regulation or requirements. Additionally, the definition of a legacy data format will be maintained indefinitely to satisfy decoding requirements for archived data sets

6.2.2 Aviation Migration Issues:

Migration Completion Date: There has been much discussion regarding when the aviation community will be able to complete migration of aviation codes. Several dates have been discussed beyond the current date of 2015. The Meeting considered this issue in coordination with ICAO and agreed the date should be changed to 2016 to coincide with the scheduled implementation date of ICAO Annex 3 8. ICAO agreed to provide correspondence indicating their concurrence.

GRIB1 to GRIB2: The original date for deprecating GRIB1 was 2008. It is widely accepted that GRIB1 use for aviation will exceed this date. Several alternate dates have been expressed and discussed in various venues but any approved change. These dates vary from 2010 to 2016. The Meeting considered this in coordination with ICAO. The Meeting recognized ICAO was planning pre-operational trials of some GRIB2 products beginning in 2007. The Meeting agreed the date for completion of migration from GRIB1 to GRIB2 should be 2010 to coincide with the scheduled implementation date of ICAO Annex 3.

6.2.3 The updated Code Migration Schedule can be found in Annex to this paragraph.

6.3 REPRESENTATION OF PECULIAR BULLETINS AND REPORTS (NIL, COR, AMD, RTD)

The Meeting reviewed solutions to solve transmission of some peculiar reports in BUFR, in particular the representation of NIL reports.

6.3.1 Corrected, Amended, Delayed and NIL Binary Bulletins

The CT had reviewed the regulations regarding representing corrected (CCx/COR), Amended (AAx/AMD), Delayed (RRX/RTD) and NIL binary bulletins in the current GTS manual. For corrected, amended and delayed bulletins the guidance seems to be clear. For NIL bulletins however, the guidance is specific for alphanumeric bulletins and no mention of NIL exists for binary bulletins. Therefore, when generating BUFR bulletins there is no clearly defined mechanism to indicate a NIL report or NIL bulletin.

The Meeting reviewed the previous report from the CT-MTDCF meeting in Geneva (November 2005) on NIL. The Meeting discussed the difficulties and various aspects and requirements for the Bulletin-based monitoring and for the Report-based monitoring. It was identified that there was definitely a need for the Bulletin-based monitoring to define a reporting practice for indicating an empty binary bulletin. This was due to the fact that in WWW monitoring there was an important and traceable technical difference between a NIL report, a NIL bulletin, and a missing bulletin.
The proposal for indicating a bulletin as NIL is:

(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) T_1T_2AAii CCCC YYGGgg BBB
(CR)(CR)(LF) NIL=
(CR)(CR)(LF)(ETX)

This solution was found consistent for the Bulletin-based monitoring and accepted. The Meeting has agreed that this solution should be addressed to ET/OI and ET/WIS as the proposed solution for the identification of a BUFR bulletin as NIL, and containing no reports. Regarding the handling of COR, AMD and RTD qualifiers in GTS abbreviated headers, GTS provides optional BBB in the abbreviated header to flag the corrected, amended and retard bulletin.

6.3.2 For the purpose of the Report-based monitoring the Meeting confirmed that marking all data fields in a particular BUFR subset as Missing, except the WMO Station Identifier (identification of the station or observing site) and the delayed replication factors, should be the solution used for making a NIL report for a certain station. Then, within the monitoring, for identifying a NIL report, it will be sufficient to determine the Station Identifier and then to recognize that the year & month are Missing for that subset; the date and time of the NIL report should be evaluated from the Section 1.

The Meeting agreed that the proposal for both the Report and Bulletin NIL reporting should be recommended to ET/OI and ET/WIS for an update to the Manual on the GTS 386, and for a consideration to ICT/ISS and CBS in 2006, in order to enable a proper way of monitoring of BUFR reports for AGM 2007.

6.4 PROBLEMS SPECIFIC TO AVIATION

There is an especially strong requirement for OPMET data (METAR/SPECI and TAF), where COR, AMD are elements of the current METAR/SPECI and or TAF code and should be included in the BUFR templates. In the case of OPMET data (METAR/SPECI and TAF), NIL, which is an element of the current TAC, should be included in the corresponding BUFR templates.

Units of measurement and their conversion: In general the ICAO was using non-standard units in the METAR/SPECI and TAF codes. Further more; the usage of non-standard units at the airports was widely spread. The ET/DR&C agreed that the BUFR system should be applications oriented to favour the spread of its use. For that purpose users using non-standard units could be satisfied when justified, however the ET had concerned that it might create instabilities in the BUFR messages and Tables. Nevertheless, considering the importance for aviation applications, the Meeting agreed to allow use of non-standard units as such, provided they were defined in Common Table C-6. *It recommended that a note be added in the BUFR regulations, which limit the use of non-standard units in BUFR to aviation usage.*

BUFR Tables for METAR/SPECI and TAF: The CT noted that draft Amendment 74 to Annex 3/WMO Technical Regulations (C.3.1) contains a proposal to allow the bilateral exchange of OPMET data using table-driven codes between States/Members in a position to do so. As a consequence of this proposal it is vital that the BUFR code tables for METAR/SPECI and TAF are completed in time for the proposed applicability date of November 2007.

At the request of ICAO, it was agreed that non-standard national practices should not be included the BUFR templates for METAR/SPECI and TAF data.

6.5 QUESTIONS REGARDING TEMP and PILOT BUFR TEMPLATES

The Meeting discussed some issues brought forward by Dr Weiqing Qu (Australia) regarding how to encode TEMP and PILOT BUFR Templates. Vertical profile data (TEMP and PILOT data) shall be included in descending order with respect to pressure (ascending order with respect to height). Data at each level shall be included only once. The multiple attributes shall be indicated by Extended vertical sounding significance (Flag table 0 08 042) as specified in the relevant B/C Regulations.

However, if data are produced and collected in traditional codes and converted into BUFR or CREX in the national centre, the order of levels may correspond to the order of levels in Parts A, B, C and D. In this case, data at a level may be included more than once. This approach should be considered as a temporary solution to speed up the migration process.

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6.6 USE OF CREX

6.6.1 The Secretariat informed the Meeting, that West African countries were planning to use CREX code for coding Squall Line information; squall lines are the most significant and important meteorological phenomena in that part of the world. The proposed templates are listed in Annex to this paragraph.

6.6.2 Questions regarding the coding in CREX of synoptic observations had been sent to the Secretariat. The Meeting provided answers as listed in Annex to this paragraph. The Meeting also recommended that examples of coded CREX messages be put into the WMO web site.

6.6.3 Plan for migration in Tanzania Meteorological Agency (TMA)

Mr William Amos Chillambo provided an outline of the efforts made by Tanzania Meteorological Agency in implementing the WMO Migration to TDCF plan.

6.6.3.1 The Training Seminar on Table Driven Code Forms held in Arusha, Tanzania in February 2003 opened a way towards the start of implementation of the migration plan. The Tanzania Meteorological Agency has managed to lay down the National Migration Plan and has implemented a National Training Programme on TDCF for her basic operational (core business) staff. The proposed National Migration Plan has taken into consideration the WMO proposed code migration schedule, however, the dates in most cases differ because it solely depended on the availability of funds. It should also be noted that Tanzania embarked on the exercise rather late. The proposed schedule is shown in Annex to this paragraph.

6.6.3.2 Upon successful implementation of the training programme, Tanzania received a request from Botswana Meteorological Service for training four staff. The training was successfully conducted from 13th to 23rd February, 2006. Tanzania has received other requests from Ethiopia, Kenya and Uganda who have shown interest of joining in the migration process. In line with the training activity, Tanzania Meteorological Agency has ventured into composing a CREX Test Message as presented in Annex to this paragraph. Pre-ready frame for encoding in CREX with matrix and check digits have been defined also. TMA has selected few stations to compose the normal observations into CREX messages and route them to the Central Forecast Office for further scrutiny. The Meeting congratulated Tanzania for the work done.

6.6.3.3 , In a Region where for a long-time half the countries have still no automated data processing, and where the majority have still manual observations and operators for national concentration like Tanzania:

- Leased lines
- SSB
- Telephone lines
- Internet
- Cellular (radio, Primcel-SMS)

CREX might be the needed intermediate solution if one wants to transmit more accurate parameters and extra and correct meta-data. The Meeting recommended strongly that check digits be used for the exchange of CREX messages on the GTS to ease decoding and quality check by automated centres. Perhaps more explanation for CREX coding is needed in some of the new regulations for TDCF.

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6.6.3.4 Surely the successful implementation of the migration to table driven codes in developing countries largely depends on capacity building. Assistance to developing countries in the form of pilot and specific projects is necessary. Since Tanzania has moved this step forward, it is requested that personnel involved in delivering the knowledge be given further training/experience through attachment at advanced centres. TMA needs also assistance in the acquisition and implementation of CREX decoders programme. They have all indicated need for training, and this will require financial assistance to enable resource persons to travel to these countries to conduct the course.

6.6.3.5 The Meeting agreed that assistance was required to help these countries to implement the migration. The Meeting recommended that a new training programme for RA I, with different means and content (to focus more on the implementation rather that the detailed code knowledge) was necessary. Training the “code trainers” should be the priority. Funds and resourcing were a problem. Advanced Centres should assist in promoting the capability of personnel involved for delivering the knowledge and thus helping for accelerating the pace of migration in RA1.

6.7 EXPERIENCE OF MANUFACTURERS

The Meeting was pleased of the presence as observers of Mr Paul Heppner (from 3 SI, USA) and Mr Michal Weis (from IBL Software Engineering, Slovak Republic) who reported some of their experience in development connected with BUFR or GRIB implementation. In particular Mr Michal

Weis submitted a document where problems identified with TDCF data processing were listed as indicated below.

Introduction

It was observed that there was a significant gap between TDCF producers and the final users at the data-processing level. Both groups have different expectations from the software, from the data processing and have a different level of knowledge of data. These differences are most highlighted when using TDCF data from a different or unknown provider. The main reasons for this dichotomy were probably the common misunderstanding resulting from not making a difference between decoding and understanding/interpretation. The absence of validation procedure/facilities for TDCF producers was also a source of deviations from the standard, which were undetected by the producers themselves.

Data testing

During data-integration process it was often requested to integrate various TDCF (BUFR) data from different producers. However it was often observed that TDCF codes were not correct as they were only tested by the producer itself, and very rarely tested with a different consumer.

The data testing between a TDCF consumer and a TDCF producer is a necessary step, which is very time-consuming. During this iterative process, errors of producer are identified, feedback is provided, then analyzed, and guidance has to be provided for troubleshooting. This is a time-critical activity, requiring a very high level of knowledge of TDCF rules, as well as of the coded data itself, and it is needed because of the absence of a self-testing/validation procedure for TDCF producers. In fact, TDCF producers assumed the code is correct, having no possibility for crosschecking or validation by another party.

Most common errors occurred in the selection of a proper representation (templates were used very rarely or not at all), in the identification and interpretation (the meaning of a code was often not known), in the use of old TDCF-writing libraries (where the subcategory field is not implemented), and in logical or data-integrity errors (e.g. in a certain SYNOP BUFR implementation the pressure tendency was always positive and its characteristic was missing).

Gap between encoding process and users

In a supposed homogenous environment, typically inside a single NWS, the situation is much simpler as the know-how is available in-house. However, even here, deviations, like those found in an heterogeneous environment, are appearing: the reason is that software from different providers are in use, with various levels of configuration capabilities, maintainability, and possibilities of changes.

It was observed that users of the TDCF, which were at the end of the data-chain, often misunderstood the procedure and did not make a difference between decoding and displaying. It was assumed that by decoding, the data processing software was capable of displaying any TDCF in any way (i.e. interpretation). When TDCF-written codes available in-house were of a different age, the actual interpretation was often difficult as templates were not followed, and without the sub-category (available in Edition 4) it was not possible to identify what a particular code really contained, how it should be interpreted and how it should be displayed.

This problem is increased in heterogeneous environments where multiple producers are available, and data-producers are different than data-users. Often, It was not known what certain BUFR reports contained and who should be contacted for more information, although the data-users still assumed that decoding equals understanding/displaying. Older editions are often used (even Edition 1), which resulted in difficulties for the identification of the data.

6.8 USE OF XML

6.8.1 As tasked by CBS, the previous ET/DR+C meetings in Kuala Lumpur (June 2004) and Muscat (December 2005) have both included lengthy discussions on the topic of XML. At both meetings, it was generally acknowledged that XML could be a useful exchange mechanism for small amounts of data and that some WMO guidance on nomenclature, conventions and/or best practices might be useful in order to assist member countries in this effort. However, there had been minimal XML experience reflected within the existing membership of the ET/DR+C, so the need to involve additional subject-matter experts was repeatedly emphasized.

6.8.2 Within the U.S., the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) has established a Joint Action Group (JAG) to investigate and coordinate the XML development efforts of the several national agencies delivering meteorological information. An initial web service XML-based request and response mechanism called the Joint Meteorological and Oceanographic (METOC) Broker Language (JMBL) has been developed and implemented. Given these, and other efforts by the U.S. agencies, there is a substantial body of work that the U.S. is willing to share. This body of work includes:

- Metadata/data dictionary
- Logical and physical data models represented in a data-modelling tool
- XML schemas based on the above models
- XML schemas for JMBL
- Current development of a JMBL User's Guide (in progress)
- Configuration Management Plan
- Database design documentation
- Naming Standards and Conventions documentation
- Lessons learned

6.8.3 Based on these recent developments, the U.S. supports the effort of WMO to develop XML guidance, practices, and any associated WMO standards for the representation and delivery of meteorological information using XML. Such guidance and best practices would be the first step towards increasing interoperability on an international basis. However, the scope of this guidance and best practices must be clearly defined beforehand, since many development options are available in creating XML schema. The range of options covers aspects such as modularity, granularity (size and complexity of schemas), schema structure (including the use of annotation and documentation), element naming, the use of code lists and the relationship to other WMO standardized code lists. Security may also be an issue, since vulnerabilities with XML have been recognized by the W3C. Of particular significance is the determination as to what degree data elements will be defined and managed at the WMO level versus what will be managed at local (national or below) levels. Therefore, when defining the scope of the guidance, it is recommended that the focus (at least initially) should be on areas which promote the highest degree of interoperability, have the greatest impact, may be implemented in the shortest amount of time and have a minimum implementation cost. The U.S. has a substantial body of work to share in such an effort, and would like to volunteer involvement in all steps of the development and decision process for any such future guidance, best practices, and associated WMO standards for XML.

6.8.4 The UK Met Office indicated also its involvement with various groups in developing XML Meta data standards for XML. As mentioned previously, the current ET/DR+C does not possess the technical knowledge required to address many of these issues, so the Meeting agreed that convening of a separate expert team, either as a subgroup to the ET/DR+C or as a separate stand-alone team charged with the resolution of such matters (currently tasked to the ET/DR+C), seems warranted. A good idea would be to define standard meteorological XML schemas that are tightly coupled with CREX/BUFR tables. A one-time international workshop, with subsequent coordination via email, teleconferencing, etc. would also be necessary to define what to do and at what level it has to be done.

6.9 USE OF NETCDF

6.9.1 As already said before by the Teams, NetCDF was also an envelope to exchange scientific data. It was also self-describing and a lot of interface sub-routines and various facilities have been developed along the years. And as for XML, when people started to use intensively NetCDF they realized that they needed some agreed standards in the definition of parameters to be exchanged. Thus, there was the example of the development of a Climate and Forecast (CF) convention for NetCDF by some universities, laboratory and various agencies. UKMO indicated that there was plan to involve the World Climate Research Programme in this endeavour.

6.9.2 The Meeting considered that NetCDF was array driven and file oriented, and that it was more appropriate for fields than for observations. It was somehow acceptable for data retrieval, but surely unusable for real time automatic operational exchange on the GTS. The Meeting acknowledged its lack of expertise in the field and it would require a big amount of time to do the work. It repeated the need to hire a consultant to establish the exact requirements, to define the tasks to put standards for parameters in a convention, how to link it with GRIB 2 and identify what had to be done. The consultant should have expertise in NetCDF as well as good knowledge of GRIB 2. The Meeting welcomed the idea of involving WCRP, but wished the standard be connected somehow with the existing parameter definitions in GRIB 2.

7. TASKS FOR MIGRATION

The Meeting considered the tasks needed to improve the process for migration to TDCF and realized that numerous tasks remained to be done, especially for helping developing countries.

7.1 FACILITATION OF OPERATIONAL IMPLEMENTATION AND PRE-OPERATIONAL TESTING

The Meeting considered how to provide central coordination of activities including preoperational testing and operational implementation.

TDCF in WMO web server

7.1.1 The Meeting stressed the need (for any development and understanding by all NMHS) to have Code Tables, Templates, Guides and Migration information always up-to-date in the WMO web server and asked the WMO Secretariat to provide sufficient manpower to perform this task, when change occurs without any delay. A special Migration News page could be inserted, as well as in the WWW Newsletter.

Code Tables in machine-readable form

7.1.2 The need of Code Tables in machine-readable form (for example BUFR itself, CSV or XML) was stressed again to facilitate development and the Meeting called on for a member to make available these Tables in such a format, since the Secretariat did not have the expertise nor the means, neither the time to generate such format efficiently. Once these Tables in these different formats would be generated, they could be made available in the WMO web server.

Data verification service

7.1.3 To facilitate the migration process to TDCF, a validation service was considered for BUFR and CREX coded data. The Meeting agreed on the need for a centrally organized web-based validation service to facilitate operational implementation and pre-operational testing of migrated data flows. Because the service was to verify that data complied with agreed standards and regulations, it had been named “data verification service”.

7.1.3.1 The ideal would be a unique webpage that offers the ability to upload bulletins and/or messages in BUFR en CREX format. Uploaded data would be validated instantly and results would be presented by a webpage. Initially, this validation could be decoding checks only. Additional checks to validate the contents more precisely could be added over time. It would be appropriate to implement such a validation service at a website that offered also decoding and encoding software for BUFR and CREX (e.g. ECMWF). It would not necessarily mean that the development of this service would have to take place at the organization managing the website (an example of a validation service for HTML is offered by W3C, see http://validator.w3.org/). The establishment of an automatic validation tool on-line in a web site (WMO Web or other) would help TDCF producers to validate codes with third-party, and to perform cross checks. Proposed checks could cover:

- Test for international descriptors, valid at time
- Test for Sequences matching known templates, and TM-sequences
- Internal data integrity (cross-checks)
- Visualization (preview) of tested data
- Validation against co-provided TAC

7.1.3.2 To establish the data verification service for BUFR and CREX data, the following approach had been agreed:

1. Identification of requirements:
   Requirements are collected, prioritized and selected for implementation.

2. Development and implementation of the service:
   Given selected requirements, the web-based service is developed and implemented.

7.1.3.3 For the development of requirements an initial specification document will be prepared by Jan Willem Noteboom (KNMI) and distributed to the team members for review and contributions. Because it is expected that not all requirements can be implemented in the first release of the service, a selection has to be made. This selection will be based on priorities given to the individual requirements by all team members.

Examples of requirements:
Decoding checks (edition, tables references etc), template checks (correct usage of migration templates), cross-checks (comparison of data in TACs versus BUFR/CREX).

7.1.3.4 Milan Dragosavac (ECMWF) was willing to arrange the development and implementation of the verification service. Also other team members are willing to provide contribution, but might require permission from their organizations.

7.2 CONTACTS WITH OTHER ORGANIZATIONS

As stated in its terms of reference, the CT recognized the need to coordinate its activities and work together with other relevant international bodies including ICAO, CAeM, IOC, JCOMM and the satellite operators in order to co-ordinate, agree and resolve migration issues related to specific code types. Additionally, the Team is tasked to coordinate with Regional Focal Points, National Migration Steering Groups and Codes Focal Points, RTH Focal Points and others too, as needed, to identify problems and develop and implement solutions. *Information should be passed to the Regional Rapporteurs on Codes and Data Management or ISS.*

7.2.1 Fred Branski informed the Meeting in reviewing his contacts with other Organizations.

HMEI: Fred Branski met with HMEI in January 2006 during their meeting held during the annual American Meteorological Society (AMS) meeting in Atlanta, Georgia. He also met individually with HMEI members during the AMS meeting. The status of code migration was discussed in general as well the readiness and concerns of HMEI members. Also discussed was the participation of HMEI members as observers in CBS codes related meetings. This was in follow up to discussions with HMEI during the November CT-MTDCF meeting held in Geneva. The result of these discussions and consequent follow up is the active participation of HMEI observers in this meeting. The Team look forward to their continued participation and the opportunity for collaboration this will provide. This will result in the hydrometeorological industry better understanding WMO Member needs as well as having their valuable insight into operationalizing and implementing data encoding standards.

UNIDATA: Fred Branski also discussed code migration with UNIDATA and some of its members at the AMS meeting. This community in general was supportive of the migration but did not fully understand how it would affect or benefit the academic community. Some expressed concern that the WMO position would exclude other formats, which they felt, were important. There is much concern in this community that XML standards for the hydrometeorological community are developed.

American Meteorological Community: A key part of the proceedings of AMS each year is the Global Services Update session of the Interactive Information Processing Systems part of the meeting. This session is the first session following the keynote address. The WMO Secretariat briefed the Migration to TDCF in its presentation. This was especially important in communicating with all sectors of the U.S. hydrometeorological community. Additionally, this meeting is attended by representatives from many international organizations as well as from other countries.

ICAO: Although no formal discussions were held with ICAO itself since the last meeting, input has been provided regarding migration issues to representatives attending several ICAO working groups. This guidance regarding migration and aviation is coordinated with the U.S. Federal Aviation Administration, which represents the U.S. in regard to aviation policy in the U.S.

7.2.2 *JCOMM:* Jan Willem Noteboom (KNMI) provided information about a contact made with JCOMM concerning the migration of Voluntary Observing Ships (VOS).

7.2.2.1 At the first CT-MTDCF meeting an updated BUFR template for Voluntary Observing Ships (VOS) observation was presented by Eva Červená with the request to contact JCOMM if this template is acceptable to JCOMM. Because of KNMI's involvement in handling of VOS data, Jan Willem Noteboom from KNMI was asked to take on this action. He presented to the Meeting the result if this action.

7.2.2.2 At the beginning of February Mr Greame Ball was contacted (chairman JCOMM Ship Observation Team) which /SOT) and asked to verify whether the BUFR template for VOS data was acceptable to JCOMM. In addition, Mr Greame Ball was asked if JCOMM had already decided on a strategy for the TDCF migration of VOS data (given the paper about TDCF migration strategies for VOS data from Jaap van der Plank, KNMI). This contact resulted, after a lot of correspondence, in the following set of recommendations that have been included in annex VII of third International PMO workshop report (Hamburg, Germany, 23-24 March 2006). It envisaged an implementation schedule with target 2012 for operational system in place with VOS data on GTS in BUFR (see Annex to this paragraph).

7.2.3 The Chairman of ET/DRC took part in "JCOMM/OCG Workshop to establish a Pilot Project for the collection of real-time metadata regarding Sea Surface Temperature and water temperature profile data" in Reading, UK, 28-29 March 2006. This was an opportunity to learn more about the marine community requirements for real-time data and meta-data exchange and inform the workshop about WMO ET/DRC activities and migration to table driven codes.

7.2.3.1 Dr. Ed Harrison (USA), the chairperson of this workshop, introduced the following issues to be considered by the meeting:

i. Minimizing the number of duplicate records;
ii. Seeking agreed formats and practices, as several communities had been pursuing metadata development strategies;

iii. Seeking to harmonize the ocean, met-ocean and atmospheric community practices as far as possible;
iv. Reviewing metadata needs of the developing operational oceanography community.

Mr Etienne Charpentier (WMO) then presented the goals of the workshop, i.e.

i. To consider user requirements, metadata relevant for the pilot project, and to draft the list of required metadata and categorization;
ii. To identify the metadata information that needs to be available in real-time;
iii. To identify centre(s) to host/serve metadata;
iv. To develop an action plan for advancing the pilot project.

7.2.3.2 The participants enquired about the possible adjustment/extension of the Argo metadata format, with a view to the real-time distribution of all temperature profile metadata, bearing in mind that the TESAC format does not allow the distribution of metadata. Mr Milan Dragosavac (ECMWF), a Chairman of WMO CBS ET/RDC noted that BUFR code has shown its efficiency in many situations in this regard. The participants asked the Secretariat to communicate with WMO/CBS regarding the possible inclusion of metadata in BUFR tables. The participants considered that a format, for the exchange of real-time metadata, should eventually be proposed, subject to general acceptance by the ocean community including JCOMM. The workshop also invited the DBCP to work with CLS/Service Argos to make sure that any metadata required for GTS distribution along with the observations could eventually be processed for inclusion in distributed BUFR reports.

7.2.3.3 Mr Graeme Ball (Australia), the chairperson of the JCOMM Ship Observations Team (SOT), introduced the current status and plans for metadata under the Voluntary Observing Ship (VOS) and the VOS Climate Project (VOSClim). In total, there were currently 110 desired fields in VOS metadata, typically collected when recruited and only required to be altered if equipment was subsequently changed.

7.2.3.4 The participants noted that an *ad hoc* SOT Task Team on Migration to Table Driven Codes (Etienne Charpentier, Graeme Ball, Sarah North, Julie Fletcher, Frits Koek and Pierre Blouch) was established during PMO-III (Hamburg, 23-24 March 2006) to progress the introduction of BUFR from the VOS and VOSClim. A final list of requirements will be determined by 1 July 2006. The Task Team will also work with the ET/DRC to develop a BUFR template for VOS/VOSClim in time for SOT-IV (April, 2007). The participants recommended that the ad hoc SOT Task Team should interact closely with the Pilot Project in defining a new BUFR template for ship data.

7.3 TRAINING

The Meeting reviewed the achieved training activities and considered new ways, aiming at more efficiency, to train countries to implement the migration.

Status of training

7.3.1 Of the training already completed Level 2 training was most important and consisted of providing a deep understanding of the TDCF with an introduction to and use of TDCF software including debugging and interfacing it with data processing applications. Here is a summary of Level 2 training completed:

- RA I: At least one participant in 33 of 54 countries has been trained.
- RA II: At least one participant in 28 of 33 countries has been trained.
- RA III: At least one participant in 10 of 12 countries has been trained.
- RA IV: At least one participant in 17 of 21 countries has been trained.

- RA V: At least one participant in 5 of 14 countries has been trained.

- RA VI: At least one participant in 7 of 49 countries has been trained.

For all Regions the total number of countries where at least one participant was trained from 2003 to 2005 is 100 out of 183 countries.

Needs for future training

7.3.2 Of special importance in regard to the training discussion was recognition that migration is now in the operational implementation phase and training activities should support this new focus. Training should include also the development of a migration plan. One could envisage shorter courses aimed at NMHSs managers focusing more on planning and necessary resources. The Meeting agreed to three approaches to future training.

Complete Already-Planned Training

7.3.2.1 The existing Migration plan calls for several training activities which the Meeting agreed should be completed and as well as other training actions to be continued. They are:

- Train countries of RA V

- Train again RA I countries

- Continue providing general Level I training by WMO staff and other experts whenever venues and opportunities allow.

- Countries should include National Training at Level I and Level II as part of their National Migration Plans.

- Place copies of the training materials developed for the seminars on the improved WMO migration web site. Guidance should be distributed to the focal points on Code Matters and Migration to strongly encouraged them to read and use these presentations (in PowerPoint).

Training for Software and Equipment Producers

7.3.2.2 Because of the critical need for software and equipment producers to implement BUFR and CREX utilization correctly, the Meeting strongly recommended having a training seminar targeting this group. It should be done in conjunction with a joint meeting of CT/MTDCF and ET/DRC to fully maximize the benefits from having the experts available.

The Meeting also encouraged welcoming personnel from these groups as observers at future meetings of the two Teams. This would be at their own expense or that of their organizations.

Training as part of Recognized Migration Implementation Programmes

7.3.2.3 The Meeting agreed to have recognized Migration Implementation Programmes (MIP) (see chapter 7.5). An integral part of each MIP is identification of the training needs and a plan for completing the training. The Meeting recommended all future newly sponsored training be part of an approved MIP, which has, as its final result, operational implementation of an identified migration goal defined in a National Migration Plan. What is possible (with fund availability, indeed) is listed:

- WMO general workshop – one week (1 or 2 participants per country)
- Workshop by organized by advanced countries (*cheaper formula for WMO*)

- WMO fellowship to study in advanced countries for limited number of IT experts, at least a week.
- Roving seminar by visiting experts
- CAL (e.g COMET): to be developed, very expensive and less motivating for learner

7.4 MIGRATION GUIDANCE DOCUMENT

In starting to implement the migration to TDCF, Members reported difficulties, which were analyzed by the Coordination Team (CT) meeting in Geneva in November 2005. The CT considered the International Migration Plan written in 2002 and agreed there was a need to expand and update the guidance provided by the plan. From the review of the problems and issues, which had arisen so far, it appeared that many difficulties involved misunderstanding or difficulties with *implementation aspects*. This was also demonstrated by reports from some WMO members that they were ready to begin dissemination of migrated data but hadn't because they were unsure of what procedures should be followed or what permission may be needed. The CT recognized the Migration Plan had been approved by CBS and that it represented the approach, which was to be followed. The Meeting also recognized it was not the plan itself which was the issue. The CT agreed that there was a problem of visibility of the migration.

7.4.1 The CT recommended that a special information should be sent again to the PRs, in the shape of a letter accompanied with a one page information giving the main lines of actions to be taken, then an annex which would be called Migration Guidance. The Migration Guidance document, which will be targeted at the executive management, who would then become aware of the migration and relay the information to the experts involved more specifically with the different aspects of the implementation of the migration to TDCF. The new document with a focus on guidance and recommendations for implementation was needed. This new Migration Implementation Guidance document should be developed and maintained by the CT/MTDCF itself in coordination with other applicable groups such as the ET/OI, ET/DRC, ET/WIS, etc; that it be regularly updated as issues arise; that it be available on the improved WMO Migration web site; that it be focused on clear and practical guidance on how to implement migration; and that it be widely shared with RTH Focal Points, Codes Focal Points and Rapporteurs having an interest in migration.

7.4.2 The Meeting agreed that the Migration Guidance Document should be finalized before the ICT on ISS planned in September 2006. Some aspects expected in the content of the Migration Guidance are listed in Annex to this paragraph.

7.5 MIGRATION IMPLEMENTATION PROGRAMMES (MIPS)

The Meeting reviewed further the concept of pilot programmes and made recommendations for their implementation with a view to help developing countries.

7.5.1 The Coordination Team on MTDCF in November in Geneva reviewed the concept of setting up pilot programmes and considered what would be the best way to do that from the standpoint of creating the strongest assistance for implementation of migration. It decided that Migration Implementation Programmes (MIPs) should be supported if they have implementation as the defined result of their completion. It also decided these programmes should integrate the recommendations of the migration plan. The Meeting agreed to develop a template and guidance for a MIP and to make it available on an improved migration web site. Approved MIPs would require the following at a minimum:

- A National Migration Plan exists which has defined migration implementation results per the MIP guidance.

- Appropriate hardware and software capability already exists to deliver the identified migration implementation result or it is clearly documented in the MIP how this will be achieved to include funding mechanisms.

- Appropriate communications capability already exists or it is documented in the MIP how this will be achieved to include funding mechanisms.

- Appropriate training is already complete or identified as part of the MIP to include funding and availability of trainers.

7.5.2 Countries to be helped must be ready to implement (expertise, enough resources). Help for good candidate countries to have adequate hardware and software system should be initiated through: expert assessment missions, followed if necessary by special funding: e.g. World Bank, EU, VCPs, regional grouping. Selected developing countries may be helped, if funds were available, by pursuing the organization of workshops on philosophy and techniques (including practical sessions) of migration to these codes; the courses should include training on how to develop a migration plan. The CT also suggested that WMO might support participants for attending appropriate courses. Training might take place in the form of attachment of staff to advanced centres (for 2-3 weeks), visiting experts (for 1-2 weeks) or capacity building workshops.

8. FUTURE WORK

8.1 PROPOSAL FOR SPLITTING THE ET/DR&C

8.1.2 Fred Branski, Chair CT-MTDCF informed the Meeting of a proposal to split the ET/DR&C between:

- A Data Definitions Working Group who will be responsible for maintaining and updating data definitions – a task that needs to be able to respond rapidly to changing user requirements. This Working Group would be concerned with defining the contents of BUFR and GRIB tables, the catalogues and registries for the metadata standards, WMO interpretation of the CDF standard and definitions of quantities within XML schema (and any other similar standards that are required).

And:

- A Data Infrastructure Expert Team who will be responsible for the more slowly varying structures within which the Data Definitions Working Group works. This Expert Team would define new versions of the WMO Core Metadata Profile, changes to BUFR and GRIB, standards for representing data in XML etc.

8.1.3 The Meeting considered that this proposal would not be workable for two reasons:

iii. The change of structure is definitely connected with the requirement for additional features to data representation, which have to be analyzed in themselves, and might lead to structure changes, but not always.
iv. The volume of work for TDCF codes is largely enough for a single team. Mixing expertise of the Team in NetCDF and XML would require a much bigger membership, with people working virtually independently.

If one wants to push XML and NetCDF two other teams need to be created to work with their own agenda. One could foresee sometimes a common meeting between the 2 or 3 teams to ensure commonality of standard definitions where it is required.

8.2 LIST OF RECOMMENDED ACTIONS:

2.2.1 Parameters for GEMS – *Action: ECMWF to revisit*.

2.2.2 Check the GRIB2 Guide and list any other possible needed amendments *(Action: Team).*

3.2.1.5 Validation of atmospheric chemistry descriptors to be undertaken rapidly *(Action: Team).*

3.4.4 CREX template for exchange of sea level data for tsunami warning – Aim to create a template by June 2006, ready for validation. *Action: Charles Sanders, Dr Eva Červená and Atsushi Shimazaki to contact representatives of the ICG/PTWS and ICG/IOTWS to obtain the required additional information*.

3.4.5.3 New Descriptors for GHRSST data – *Action: to make a review by email within the Expert team.*

3.4.5.4 Requirements for Data from Automatic Weather Stations – *Action: Dr Eva Červená accepted to contact the producers of this template to fix with them the points needing improvements.*

4.1.2 Proposed changes to SIGMET - to be included for operational implementation in BUFR Template on 7 November 2007. *(Action: Jeff Ator)*

5.1 PROPOSED OBSERVATIONS REPORTING PRACTICES FOR TDCF IN MANUAL ON CODES
*(**Action**: volunteers to verify regulations of one type before September)*

5.2 PROPOSAL FOR COVERAGE OF REGIONAL REPORTING PRACTICES IN BUFR TEMPLATES FOR TAC - *these templates should be reviewed and approved by Regional Associations to be included in Volume II of the Manual on Codes.*

5.3.1 Procedural issues for national reporting practices – *Action: members to provide advice and suggestions for solving the actual problems, especially to national focal point on code matters.*

5.3.2 ET-OI reviews this situation and that the Manual on the GTS, WMO-No.386, be updated to specify usage of ii for designation of "additional" data as defined in Resolution 40 (Cg-XII) not only for bulletins compiled in traditional alphanumeric codes, but also for bulletins compiled in GRIB, BUFR or CREX code.

5.5 Review METAR/SPECI/TAF templates and related BUFR sequences and parameters – *Action: Charles Sanders tasked to give a revised and final version of the template.*

6.1.1 *Countries creating new BUFR bulletins should inform the Secretariat of new bulletins made available on the GTS.*

Passing more Information about the Migration to all WMO PRs. A circular letter with appropriate documentation should be sent. Another questionnaire should be dispatched *(Action: Secretariat).* More consideration of the subject in constituent body meetings (JCOMM; CCI, AeM, CBS; EC and Congress) would be necessary *(Action: Secretariat).* Associating RTH focal points for the dissemination of information on migration was also a necessity *(Action: Secretariat).* The Meeting recommended that the last up to date migration status information should be given at the next CBS in November 2006 *(Action: members providing information to Secretariat before November 2006).*

6.3.2 *Proposal for both the Report and Bulletin NIL reporting should be recommended to ET/OI and ET/WIS for an update to the Manual on the GTS 386, and for a consideration to ICT/ISS and CBS in 2006, in order to enable a proper way of monitoring of BUFR reports for AGM 2007.*

6.4 N*ote be added in the BUFR regulations, which limit the use of non-standard units in BUFR to aviation usage (Action: Secretariat).*

6.6.2 Examples of coded CREX messages be put into the WMO web site *(Action: to be provided to Secretariat for insertion).*

6.6.3.3-*Check digits be used for the exchange of CREX messages on the GTS to ease decoding and quality check by automated centres. Perhaps more explanation for CREX coding is needed in some of the new regulations for TDCF.*

6.6.3.5 *Assistance required helping countries to implement the migration. New training programme for RA I, with different means and content (to focus more on the implementation rather that the detailed code knowledge). Training the "code trainers" should be the priority. Advanced Centres to assist in promoting the capability of personnel involved for delivering the knowledge in RA1.*

7.1.1 Code Tables, Templates, Guides and Migration information always up-to-date in the WMO web server and WMO Secretariat to provide sufficient manpower to perform this task, when change occurs without any delay. A special Migration News page could be inserted, as well as in the WWW Newsletter *(Action: Secretariat).*

7.1.2 Code Tables in machine-readable form (for example BUFR itself, CSV or XML) *(Action: a member to make available these Tables in such a format)* and made available in the WMO web server *(Action: secretariat).*

7.1.3.3 Data verification service- initial requirements specification document prepared *(Action: Jan Willem Noteboom)* and distributed to the team members for review and contributions *(Action: Team).*

7.1.3.4 To arrange the development and implementation of the verification service *(Action: Milan Dragosavac)* - to provide contribution, but permission from their organizations *(Action: Other team members)*.

7.2 CONTACTS WITH OTHER ORGANIZATIONS- Coordinate activities and work together with other relevant international bodies including ICAO, CAeM, IOC, JCOMM and satellite operators - Coordinate with Regional Focal Points, National Migration Steering Groups and Codes Focal Points, RTH Focal Points and others too, as needed, to identify problems and develop and implement solutions. *Information should be passed to the Regional Rapporteurs on Codes and Data Management or ISS. (Action: all)*

7.3.2.1- Place copies of the training materials developed for the seminars on the improved WMO migration web site. Guidance distributed to the focal points on Code Matters and Migration to strongly encouraged them to read and use these presentations (in PowerPoint). *(Action: Secretariat)*

7.4.1 Special information sent again to the PRs, in the shape of a letter accompanied with a one page information giving the main lines of actions to be taken, then an annex which would be called Migration Guidance. *(Action: Secretariat)*

7.4.2 Migration Guidance Document be finalized before the ICT on ISS planned in September 2006 *(Action: all)*.

9. CLOSURE OF THE MEETING

The Meeting was closed by the Chairman of the CT/MTDCF at 18.30 on Friday 12 May 2006.

ANNEX TO PARAGRAPH 1.1

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ANNEX TO PARAGRAPH 2.2.2

In Guide to GRIB 2, Step 3: should be changed to:

Step 3: The third step in the packing operation is to scan through the field, which may or may not have been D scaled at this point, to find the minimum value of the parameter, create largest IEEE 32 bit representation value which is smaller or equal than minimum value and subtract that minimum – the reference value R – from all the data points, leaving a residual of non-negative numbers. To overcome some precision limitations of the reference value, decimal scaling should be applied if the range of the values is not significantly greater than the epsilon of the reference value (minimum difference between two values in the precision of the reference value). This step has two benefits. The first of these is convenience – making all the data points non-negative bypasses problems with different computer hardware that represent negatives in various ways. The GRIB message is rendered just that more machine independent by being non-negative throughout. The second benefit is more consequential: It can result in a substantial compression of the bulletin size without any loss of information content. If a field has an appreciable bias away from zero, the residuals formed by the minimum removal operation will all be much smaller numbers than otherwise. Thus they will need fewer bits to contain them when they are, eventually, packed as integers. The value of R is stored in octets 12-15 of the Data Representation Section.

ANNEX TO PARAGRAPH 2.2.3

Operational

Product Definition Template 4.30 to be deprecated

Product Definition Template 4.31: Satellite Product.

Octet Number(s)	Contents
10	Parameter category (see Code Table 4.1)
11	Parameter number (see Code Table 4.2)
12	Type of generating process (see Code Table 4.3)
13	Observation generating process identifier (defined by originating Centres)
14	Number of contributing spectral bands (NB)

Repeat the following 11 octets for each contributing band (nb = 1,NB)

(15+11(nb-1)) - (16+11(nb-1))	Satellite series of band nb (code table defined by originating/generating Centre)
(17+11(nb-1)) - (18+11(nb-1))	Satellite number of band nb (code table defined by originating/generating Centre)
(19+11(nb-1)) – (20+11(nb-1))	Instrument type of band nb (code table defined by originating/generating Centre)
(21+11(nb-1))	Scale factor of central wave number of band nb
(22+11(nb-1)) - (25+11(nb-1))	Scaled value of central wave number of band nb (units: m^{-1})

Note:

For "satellite series of band number", "satellite number of band number" and "instrument type of band number", it is recommended to encode the values as per BUFR code tables 0 02 020, 0 01 007 (common Code table C-5) and 0 02 019 (common Code table C-8), respectively.

Change in Code Table 4.0

31 Satellite product
32-253 Reserved

Add a Note: Product Definition Template 4.30 is deprecated. 4.31 should be used instead.

ANNEX TO PARAGRAPH 2.2.4

Pre-operational

Data representation template 5.4 Grid point data – IEEE floating point data

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Octet No.	Content
12	precision (See Code table 5.7)

Data template 7.4 Grid point data - IEEE floating point data

Octet No.	Content
6-nn	binary data values (See Code table 5.1)

ANNEX TO PARAGRAPH 2.2.5.1

To remove ambiguities the Team proposed to *(pre-operational):*

Add new regulation:

92.6.2 To maintain branching structure and orthogonality of GRIB Edition 2, parameter names in the Code table 4.2 should not contain surface type and statistical process as part of the name.

1) Add new parameters

Discipline	Category	Parameter Number	Proposed name of the parameter class	Unit
0	4	9	Net short wave radiation flux	Wm^{-2}
0	5	5	Net long wave radiation flux	Wm^{-2}

2) Deprecate:

Name of the parameter	Discipline	Category	Parameter Number
Short wave radiation flux*	0	4	2
Long wave radiation flux*	0	5	2

Note: * Parameter deprecated - See Regulation 96.2 and use another parameter instead.

3) Add parameters:

Name	Unit	Discipline	Category	Proposed Parameter number
Soil moisture	$kg\ m^{-3}$	2	0	22
Cloud cover	%	0	6	22

4) Parameters, which contain statistical process:

Deprecate parameters:

Parameter to be deprecated	Discipline	Category	Parameter Number
Maximum temperature*	0	0	4
Minimum temperature*	0	0	5
Minimum dew point depression*	0	0	14
Maximum relative humidity*	0	1	27
Maximum absolute humidity*	0	1	28
Maximum wind speed*	0	2	21
Time-integrated air concentration of caesium pollutant*	0	18	6

Time-integrated air concentration of iodine pollutant*	0	18	7
Time-integrated air concen-tration of radioactive pollutant*	0	18	8

Note: * Parameter deprecated - See Regulation 96.2 and use another parameter instead.

5) Deprecate parameters, which contain the surface type

Parameter to be deprecated	**Discipline**	**Category**	**Parameter Number**
Net short wave radiation flux (surface)*	0	4	0
Net short wave radiation flux (top of atmosphere)*	0	4	1
Net long wave radiation flux (surface)*	0	5	0
Net long wave radiation flux (top of atmosphere)*	0	5	1
Upper layer soil temperature*	2	3	1
Lower layer soil temperature*	2	3	4
Upper layer soil moisture*	2	3	2
Lower layer soil moisture*	2	3	3
Low Cloud cover*	0	6	3
Medium Cloud cover*	0	6	4
High Cloud Cover*	0	6	5

Note: *Parameter deprecated - See Regulation 96.2 and use another parameter instead.

6) Deprecate:

Parameter name	**Discipline**	**Category**	**Parameter number**
Precipitation rate*	0	1	7
Snowfall rate water equivalent*	0	1	12

Note: *Parameter deprecated - See Regulation 96.2 and use another parameter instead.

7) Add new parameters:

Parameter name	**Discipline**	**Category**	**Parameter number**
Total(1) precipitation rate	0	1	52
Total(1) snowfall rate water equivalent	0	1	53

Note: (1) Total precipitation/snowfall rate stands for the sum of convective and large-scale precipitation/snowfall rate

8) Add new parameters:

Parameter name	**Unit**	**Discipline**	**Category**	**Proposed parameter number**
Large scale precipitation rate	kg m^{-2} s^{-1}	0	1	54
Convective snowfall rate water equivalent	kg m^{-2} s^{-1}	0	1	55
Large scale snowfall rate	kg m^{-2} s^{-1}	0	1	56

water equivalent				
Total snowfall rate	m s^{-1}	0	1	57
Convective snowfall rate	m s^{-1}	0	1	58
Large scale snowfall rate	m s^{-1}	0	1	59

9) Deprecate:

Parameter to be deprecated	Discipline	Category	Parameter Number
Total precipitation*	0	1	8
Large scale precipitation*	0	1	9
Convective precipitation*	0	1	10
Convective snow*	0	1	14
Large scale snow*	0	1	15
Total snowfall*	0	1	29

Note: *Parameter deprecated - See Regulation 96.2 and use another parameter instead.

10) Deprecate:

Name of parameter	Discipline	Category	Parameter Number
Soil moisture content*	2	0	3
Maximum snow albedo*	0	19	17
Ground heat flux*	2	0	10
Water equivalent of accumulated snow depth*	0	1	13

Note: *Parameter deprecated - See Regulation 96.2 and use another parameter instead.

11) Add new parameters:

Proposed parameter name	Discipline	Category	Parameter Number	Unit	Comment
Column-integrated soil water	2	0	23	kg m^{-2}	The proposed name immediately implies that it is a vertical integral
Snow albedo	0	19	19	%	The statistical process must not be part of the name in Code Table 4.2 and the parameter snow albedo does not yet exist.
Heat Flux	2	0	24	W m^{-2}	The surface type must not be part of the name in Code Table 4.2
Snow depth water equivalent	0	1	60	kg m^{-2}	The word accumulated is misleading and Snow depth is the keyword which should be first

12) Add new parameter:

Standard deviation of sub-grid scale orography	0	3	20	m	

13. Add new parameter

Cloud ice mixing ratio	0	6	23	kg kg^{-1}	

14) *clarification from modellers needed for Total column integrated cloud water.*

15) Add new parameter

Total column integrated ozone	0	14	2	Dobson	

16) Add New parameters

Name	**Unit**	**Discipline**	**Category**	**Proposed Parameter number**
Skin temperature	K	0	0	17
Sunshine	Numeric	0	6	24
Snow density	kg m^{-3}	0	1	54
Ice temperature	K	10	2	8
Snow evaporation	kg m^{-2}	0	1	55
Large scale precipitation fraction	s	0	1	56
Downward UV radiation	W m^{-2}	0	4	9
Photosynthetically active radiation	W m^{-2}	0	4	10
Total column integrated water vapour	kg m^{-2}	0	1	57
Anisotropy of sub-gridscale orography	Numeric	0	3	20
Angle of sub-gridscale orography	Rad	0	3	21
Slope of sub-gridscale orography	Numeric	0	3	22
Gravity wave dissipation	W m^{-2}	0	3	23
Net short-wave radiation flux clear sky	W m^{-2}	0	4	11
Net long-wave radiation flux, clear sky	W m^{-2}	0	5	5

ANNEX TO PARAGRAPH 2.2.5.2

For validation

DRT 5.61: Grid point data - simple packing with logarithm pre-processing

Data Representation Template 5.61: Grid point data - simple packing with logarithm pre-processing

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 used for each packed value
21-24	Pre-processing parameter (B) (IEEE 32- bit floating-point value)

Notes:

(1) This template is appropriately designed for data sets with all non-negative values and a wide variability range (more then 5 orders of magnitude). It must not be used for data sets with negative values or smaller variability range.

(2) A logarithm pre-processing algorithm is used to fit the variability range into one or two order of magnitudes before using the simple packing algorithm. It requires a parameter (B) to assure that all values passed to the logarithm function are positive. Thus scaled values are Z=log(Y+B), where Y are the original values, log is the natural logarithm function and B is chosen so that Y+B>0.

(3) Best practice follows for choosing the B pre-processing parameter.

1. If the data set minimum value is positive, B can be safely put to zero.
2. If the data set minimum is zero, all values must be scaled to become greater than zero and B can be equal to the minimum positive value in the data set.

(4) **Data shall be packed using Data template 7.**

ANNEX TO PARAGRAPH 3.1.1

NEW ALLOCATED BUFR/CREX ENTRIES (AWAITING VALIDATION)

ADDITIONS FOR REPORTING CORRECTLY INSTANTANEOUS RADIATION

Table reference	*Element name*	*Unit*	*Scale*	*Reference value*	*Data width*
0 14 061	Instantaneous long-wave radiation	W m^{-2}	0	-512	10
0 14 062	Instantaneous short-wave radiation	W m^{-2}	0	-2048	12

The Class 14 element descriptors 0 14 017 and 0 14 018 should be deprecated by a note.

BUFR TEMPLATE FOR SYNOPTIC REPORTS FROM SEA STATIONS SUITABLE FOR SHIP OBSERVATION DATA FROM VOS STATIONS

Sequence descriptor numbers written in blue in this template, have not yet been included in Manual on Codes, WMO-No. 306, I.2 (November 2005).

Proposed new descriptor for Depth below sea water surface (High resolution)

TABLE REFERENCE			TABLE ELEMENT NAME	BUFR				CREX		
				UNIT	SCALE	REF. VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
F	X	Y								
0	07	063	Depth below sea/water surface	m	2	0	20	m	2	7

3 08 008 = 3 01 093 + 3 02 062 + 3 02 063

3 01 093			**Ship identification, movement, type, date/time, horizontal and vertical coordinates**	Unit, scale
	3 01 036	0 01 011	Ship or mobile land station identifier **D....D**	CCITT IA5, 0
		0 01 012	Direction of motion of moving observing platform(3) $\mathbf{D_s}$	Degree true, 0
		0 01 013	Speed of motion of moving observing platform(4) $\mathbf{v_s}$	m s^{-1}, 0
		0 02 001	Type of station ($\mathbf{i_x}$)	Code table, 0
		0 04 001	Year	Year, 0
		0 04 002	Month	Month, 0
		0 04 003	Day **YY**	Day, 0
		0 04 004	Hour **GG**	Hour, 0
		0 04 005	Minute **gg**	Minute, 0
		0 05 002	Latitude (coarse accuracy) $\mathbf{L_aL_aL_a}$	Degree, 2
		0 06 002	Longitude (coarse accuracy) $\mathbf{L_oL_oL_oL_o}$	Degree, 2
	0 07 030		Height of station platform above mean sea level	m, 1
	0 07 031		Height of barometer above mean sea level	m, 1
3 02 062			**SHIP "instantaneous" data from VOS**	

			Pressure data	
	3 02 001	0 10 004	Pressure **$P_0P_0P_0P_0$**	Pa, –1
		0 10 051	Pressure reduced to mean sea level **PPPP**	Pa, –1
		0 10 061	3-hour pressure change **ppp**	Pa, –1
		0 10 063	Characteristic of pressure tendency **a**	Code table, 0
			Temperature and humidity data	
	3 02 052	0 07 032	Height of sensor above marine deck platform (for temperature measurement)	m, 2
		0 07 033	Height of sensor above water surface (for temperature measurement)	m, 1
		0 12 101	Temperature/dry-bulb temperature(sc.2) **s_nTTT**	K, 2
		0 02 039	Method of wet-bulb temperature measurement	Code table, 0
		0 12 102	Wet-bulb temperature (scale 2) **$s_wT_bT_bT_b$**	K, 2
		0 12 103	Dew-point temperature (scale 2) **$s_nT_dT_dT_d$**	K, 2
		0 13 003	Relative humidity	%, 0
			Visibility data	
	3 02 053	*0 07 032*	Height of sensor above marine deck platform (for visibility measurement)	m, 2
		0 07 033	Height of sensor above water surface (for visibility measurement)	m, 1
		0 20 001	Horizontal visibility **VV**	m, –1
	0 07 033		Height of sensor above water surface (set to missing to cancel the previous value)	m, 1
			Precipitation past 24 hours	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 034	0 07 032	Height of sensor above marine deck platform (for precipitation measurement)	m, 2
		0 13 023	Total precipitation past 24 hours **$R_{24}R_{24}R_{24}R_{24}$**	kg m^{-2}, 1
	0 07 032		Height of sensor above marine deck platform (set to missing to cancel the previous value)	m, 2
			Cloud data	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 004	0 20 010	Cloud cover (total) **N**	%, 0
		0 08 002	Vertical significance	Code table, 0
		0 20 011	Cloud amount (of low or middle clouds) **N_h**	Code table, 0
		0 20 013	Height of base of cloud **h**	m, –1
		0 20 012	Cloud type (low clouds C_L) **C_L**	Code table, 0
		0 20 012	Cloud type (middle clouds C_M) **C_M**	Code table, 0
		0 20 012	Cloud type (high clouds C_H) **C_H**	Code table, 0
	1 01 000		Delayed replication of 1 descriptor	
	0 31 001		Delayed descriptor replication factor	Numeric, 0
	3 02 005	0 08 002	Vertical significance	Code table, 0
		0 20 011	Cloud amount (N_s) **N_s**	Code table, 0
		0 20 012	Cloud type (C) **C**	Code table, 0
		0 20 013	Height of base of cloud (h_sh_s) **h_sh_s**	m, -1
	0 08 002		Vertical significance (set to missing to cancel the previous value)	Code table, 0
			Icing and ice	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 055	0 20 031	Ice deposit (thickness) **E_sE_s**	m, 2
		0 20 032	Rate of ice accretion **R_s**	Code table, 0
		0 20 033	Cause of ice accretion **I_s**	Flag table, 0

		0 20 034	Sea ice concentration c_i	Code table, 0
		0 20 035	Amount and type of ice b_i	Code table, 0
		0 20 036	Ice situation z_i	Code table, 0
		0 20 037	Ice development S_i	Code table, 0
		0 20 038	Bearing of ice edge D_i	Degree true, 0

			Sea/water temperature	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 056		**Sea Surface Temperature, method of measurement, and depth**	
		0 02 038	Method of sea surface temperature measurement	
		0 07 063	Depth below sea water surface (High resolution) (for sea surface temperature measurement)	
		0 22 043	Sea/water temperature $s_sT_wT_wT_w$	Code table,0,K,2
		0 07 063	Depth below sea water surface (High resolution) (of sensor) (set to missing to cancel the previous value)	
			Waves	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 021	0 22 001	Direction of waves	Degree true, 0
		0 22 011	Period of waves $P_{wa}P_{wa}$	s, 0
		0 22 021	Height of waves $H_{wa}H_{wa}$	m, 1
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 024	0 22 002	Direction of wind waves	Degree true, 0
		0 22 012	Period of wind waves P_wP_w	s, 0
		0 22 022	Height of wind waves H_wH_w	m, 1
		1 01 002	Replicate 1 descriptor 2 times	
		3 02 023	Swell waves (2 systems of swell) $d_{w1}d_{w1}$, $P_{w1}P_{w1}$, $H_{w1}H_{w1}$ $d_{w2}d_{w2}$, $P_{w2}P_{w2}$, $H_{w2}H_{w2}$	
3 02 063			**SHIP"period" data from VOS**	
			Present and past weather	
	3 02 038	0 20 003	Present weather **ww**	Code table, 0
		0 04 024	Time period in hours	Hour, 0
		0 20 004	Past weather (1) W_1	Code table, 0
		0 20 005	Past weather (2) W_2	Code table, 0
			Precipitation measurement	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 040	0 07 032	Height of sensor above marine deck platform (for precipitation measurement)	m, 2
		1 02 002	Replicate next 2 descriptors 2 times	
		0 04 024	Time period in hours t_R	Hour, 0
		0 13 011	Total precipitation / total water equivalent of snow **RRR**	kg m^{-2}, 1
			Extreme temperature data	
	1 01 000		Delayed replication of 1 descriptor	
	0 31 000		Short delayed descriptor replication factor	Numeric, 0
	3 02 058	0 07 032	Height of sensor above marine deck platform (for temperature measurement)	m, 2
		0 07 033	Height of sensor above water surface	m, 1

			(for temperature measurement)	
		0 04 024	Time period or displacement	Hour, 0
		0 04 024	Time period or displacement (see Notes 1 and 2)	Hour, 0
		0 12 111	Maximum temperature (scale 2) at height and over period specified **$s_nT_xT_xT_x$**	K, 2
		0 04 024	Time period or displacement	Hour, 0
		0 04 024	Time period or displacement (see Note 2)	Hour, 0
		0 12 112	Minimum temperature (scale 2) at height and over period specified **$s_nT_nT_nT_n$**	K, 2
			Wind data	
	3 02 064	0 07 032	Height of sensor above marine deck platform (for wind measurement)	m, 2
		0 07 033	Height of sensor above water surface (for wind measurement)	m, 1
		0 02 002	Type of instrumentation for wind measurement **i_w**	Flag table, 0
		0 08 021	Time significance (= 2 (time averaged))	Code table, 0
		0 04 025	Time period (= - 10 minutes, or number of minutes after a significant change of wind)	Minute, 0
		0 11 001	Wind direction **dd**	Degree true, 0
		0 11 002	Wind speed **ff**	m s^{-1}, 1
		0 08 021	Time significance (= missing value)	Code table, 0
		1 03 000	Delayed replication of 3 descriptors	
		0 31 001	Delayed descriptor replication factor	Numeric, 0
		0 04 025	Time period in minutes	Minute, 0
		0 11 043	Maximum wind gust direction	Degree true, 0
		0 11 041	Maximum wind gust speed 910f_mf_m, 911f_xf_x	m s^{-1}, 1

Notes:

1) Within RA-IV, the maximum temperature at 1200 UTC is reported for the previous calendar day (i.e. the ending time of the period is not equal to the nominal time of the report). To construct the required time range, descriptor 004024 has to be included two times. If the period ends at the nominal time of the report, value of the second 004024 shall be set to 0.

2) Within RA-III, the maximum day-time temperature and the minimum night-time temperature is reported (i.e. the ending time of the period may not be equal to the nominal time of the report). To construct the required time range, descriptor 004024 has to be included two times. If the period ends at the nominal time of the report, value of the second 004024 shall be set to 0.

3) 0 01 012: Means course made good (average course over the ground) during the three hours preceding the time of observation.

4) 0 01 013: Means speed made good (average speed over the ground) during the three hours preceding the time of observation.

5) If "plain language" text is reported within Section 2, this information can be conveyed in BUFR via the use of an appropriate 205YYY field as an extra descriptor following the above basic template.

ANNEX TO PARAGRAPH 3.1.2

For SIGMET, *pre-operational:*

Proposed Table B entries

Table Reference	Element name	BUFR				CREX		
F X Y		Unit	Scale	Ref. value	Data width	Unit	Scale	Data width
0 01 037	SIGMET sequence identifier	CCITT IA5	0	0	24	Character	0	3
0 01 065	ICAO region identifier	CCITT IA5	0	0	256	Character	0	32
0 08 019	Qualifier for following centre identifier	Code table	0	0	4	Code table	0	2
0 08 079	Product status	Code table	0	0	4	Code table	0	2
0 10 064	SIGMET cruising level	Code table	0	0	3	Code table	0	1
0 20 028	Expected change in intensity	Code table	0	0	3	Code table	0	1

Add the following new categories to Table A within BUFR and CREX:

13 Forecasts
14 Warnings

Add the following new code table values for BUFR/CREX Table B descriptors:

0 08 011
21 Thunderstorm
22 Tropical Cyclone
23 Mountain Wave
24 Duststorm
25 Sandstorm

0 20 008
15 Obscured (OBSC)
16 Embedded (EMBD)

0 20 024
5 Severe

Code tables for proposed new Table B descriptors:

Code figure	**0 08 019** **Qualifier for following centre identifier**
0	Reserved
1	ATS (Air Traffic Service) unit serving FIR (Flight Information Region)
2	FIR (Flight Information Region)
3	UIR (Upper Information Region)
4	CTA (Control Area)
5	VAAC (Volcanic Ash Advisory Centre)
6	MWO (Meteorological Watch Office) issuing SIGMET
7-14	Reserved
15	Missing value

Code figure	**0 08 079** **Product status**
0	Normal issue
1	Correction to a previously issued product (**COR**)
2	Amendment to a previously issued product (**AMD**)
3	Correction to a previously issued amended product (**COR AMD**)
4	Cancellation of a previously issued product (**CNL**)
5	No product available (**NIL**)
6-14	Reserved
15	Missing

Code figure	**0 10 064** **SIGMET cruising level**
0	Subsonic
1	Transonic
2	Supersonic
3-6	Reserved
7	Missing value

Code figure	**0 20 028** **Expected change in intensity**
0	No change (NC)
1	Forecast to weaken (WKN)
2	Forecast to intensify (INTSF)
3	Unknown (*)
4-6	Reserved
7	Missing value

Note: (*) This entry is not allowed in SIGMET messages.

New Table D descriptors:

		(Time period)
3 01 014	1 02 002	Replication of 2 descriptors 2 times
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
		(Description of a feature in 3-D or 2-D)
3 01 027	0 08 007	Dimensional significance, 0=Point, 1=Line, 2=Area, 3=Volume
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Replication factor [1]
	3 01 028	Description of horizontal section
	0 08 007	Dimensional significance, Missing=Cancel
		(Horizontal section of a feature described as a polygon, circle, line or point)
3 01 028	0 08 040	Flight level significance
	0 33 042	Type of limit represented by following (flight level) value
	0 07 010	Flight level
	1 01 000	Delayed replication of 1 descriptor
	0 31 002	Extended replication factor [2]
	3 01 023	Location
	0 19 007	Radius of feature [3]
	0 08 040	Flight level significance, Missing=Cancel

[1] This replication factor shall have a value of “1” when a 2-D feature is being described, whereas 3-D features may be described via any one of the following methods:

(a) Via two or more horizontal sections in successive ascending flight levels. In this case, each section shall be described by an identical number of latitude/longitude points listed in identical order (i.e. where each point x of section n is to be joined via a straight line to point x of section n+1), in order to ensure that the overall shape of the 3-D feature is unambiguously described. In this case, all values reported for 0 33 042 shall be “missing”.

(b) Via a single horizontal section with an appropriate value reported for 0 33 042, as follows. In all such cases, the corresponding horizontal section description applies throughout the entire region.
   a. A value of “0” to indicate a region above (but not including) the reported flight level and with unspecified upper bound.
   b. A value of “1” to indicate a region above (and including) the reported flight level and with unspecified upper bound.
   c. A value of “2” to indicate a region below (but not including) the reported flight level and extending to the surface.
   d. A value of “3” to indicate a region below (and including) the reported flight level and extending to the surface.

(c) Via two replications of the same horizontal section at the same reported flight level, in order to indicate a region extending both below and above (and including!) the reported flight level. In this case, the values reported for the two replications of 0 33 042 shall be as follows:
   a. Values of “3” and “1”, respectively, to indicate a region beginning from below a reported flight level, but continuing through that level upward to some unspecified point above (e.g. TOP ABV FL100).
   b. Values of “1” and “3”, respectively, to indicate a region beginning from above a reported flight level, but continuing through that level downward to some unspecified point below (e.g. CIGS BLW FL010).

[2] This replication factor shall have a value of “1” when a circle or point is being described, and it shall have a value of “2” when a line is being described. A polygon, on the other hand, shall be described via a sequence of three or more contiguous points in accordance with the note to code table 0 08 007.

[3] The value reported for 0 19 007 shall be “missing” unless the horizontal section being described is a circle.

		(SIGMET header)
3 16 030	3 01 014	Time period (for which SIGMET is valid)
	0 01 037	SIGMET sequence identifier
	0 10 064	SIGMET cruising level
	0 08 019	Qualifier for location identifier, 1=ATS unit serving FIR
	0 01 062	Short ICAO location identifier
	0 08 019	Qualifier for location identifier, 2=FIR, 3=UIR, 4=CTA
	0 01 065	ICAO region identifier
	0 08 019	Qualifier for location identifier, 6=MWO
	0 01 062	Short ICAO location identifier
	0 08 019	Qualifier for location identifier, Missing=Cancel

		(SIGMET, Observed or forecast location and motion)
3 16 031	0 08 021	Time Significance, 16=Analysis, 4=Forecast
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
	3 01 027	Description of feature
	0 19 005	Direction of motion
	0 19 006	Speed of motion
	0 20 028	Expected change in intensity
	0 08 021	Time significance, Missing=Cancel
		(SIGMET, Forecast position)
3 16 032	0 08 021	Time Significance, 4=Forecast
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
	3 01 027	Description of feature
	0 08 021	Time significance, Missing=Cancel
		(SIGMET, Outlook)
3 16 033	0 08 021	Time Significance, 4=Forecast
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Replication factor
	3 01 027	Description of feature
	0 08 021	Time significance, Missing=Cancel

		(Volcanic Ash SIGMET)
3 16 034	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 17=Volcano
	0 01 022	Name of feature
	0 08 007	Dimensional significance, 0=Point
	3 01 023	Location
	0 08 007	Dimensional significance, Missing=Cancel
	0 20 090	Special Clouds, 5=Clouds from volcanic eruptions
	3 16 031	SIGMET Observed or forecast location and motion
	1 01 000	Delayed replication of 1 descriptor
	0 31 000	Short replication factor
	3 16 032	SIGMET Forecast position
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Replication factor
	3 16 033	SIGMET Outlook
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel
		(Thunderstorm SIGMET)
3 16 035	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 21=Thunderstorm
	0 20 023	Other weather phenomenon, bit 2=Squalls or all 18 bits = Missing
	0 20 021	Type of precipitation, bit 14=Hail or all 30 bits=Missing
	0 20 008	Cloud distribution 15=OBSC, 16=EMBD, 12=FRQ, 31=Missing
	3 16 031	SIGMET Observed or forecast location and motion
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel

		(Tropical Cyclone SIGMET)
3 16 036	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 22=Tropical Cyclone
	0 01 027	WMO storm name
	3 16 031	SIGMET Observed or forecast location and motion
	1 01 000	Delayed replication of 1 descriptor
	0 31 000	Short replication factor
	3 16 032	SIGMET Forecast position
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Replication factor
	3 16 033	SIGMET Outlook
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel

		(Turbulence SIGMET)
3 16 037	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 13=Turbulence
	0 11 031	Degree of turbulence, 10=Moderate, 11=Severe
	3 16 031	SIGMET Observed or forecast location and motion
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel
		(Icing SIGMET)
3 16 038	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 15=Airframe Icing
	0 20 041	Airframe icing, 7=Severe
	0 20 021	Type of precipitation, bit 3=Liquid freezing or all 30 bits = Missing
	3 16 031	SIGMET Observed or forecast location and motion
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel
		(Mountain Wave, Duststorm or Sandstorm SIGMET)
3 16 039	0 08 079	Product status, 0=Normal Issue, 1=Correction
	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 23=MountainWave, 24=Duststorm, 25=Sandstorm
	0 20 024	Intensity of phenomena, 3=Heavy, 5=Severe
	3 16 031	SIGMET Observed or forecast location and motion
	0 08 011	Meteorological feature, Missing=Cancel
	0 08 079	Product status, Missing=Cancel

		(Cancellation of SIGMET)
3 16 040	3 16 030	SIGMET header
	0 08 079	Product status, 4=Cancellation
	3 01 014	Time period (of the SIGMET to be cancelled)
	0 01 037	SIGMET sequence identifier (of the SIGMET to be cancelled)
	0 10 064	SIGMET cruising level (of the SIGMET to be cancelled)
	0 08 079	Product status, Missing=Cancel

ANNEX TO PARAGRAPH 3.2.1.5

All for validation only

Example of descriptor sequence

We do not provide here full templates for specific instances of atmospheric constituent observations; having said this, the general structure of a descriptor sequence is envisioned as follows (where indentation indicates repeatable sub-sequences of descriptors):

- *Identification of measurement site and instrumentation*
- *Date/time of start of measurement*
- *Horizontal and vertical coordinates of measurement site*
  - *Time displacement from start of measurement (high precision)*
  - *Lat/lon displacement from start of measurement (high precision)*
  - *Vertical coordinate value (using high-precision descriptor when required)*
    - *Atmospheric constituent type (new descriptor 0 08 043 or 0 08 044)*
      - *Statistical Significance Qualifiers (0 08 023), if applicable*
      - *Measured or physical quantities (one or more measurement or forecast)*

This structure was based on the WMO BUFR template for TEMP data (aerological sounding). It would likely suit in-situ or retrieved observations taken by balloon or aircraft and retrieved (level 2) measurement products from ground-based and satellite instruments. Appropriate and sufficiently general templates would have to be designed for raw or calibrated (level 0 or 1) ground-based and satellite measurements. (e.g. spectral radiances instead of retrieved mixing ratios). Templates for the latter should preferably by extensions of the above structure and be applicable to a wide range of different instruments instead of being specific to certain instruments. As starting point, this proposal focuses on quantities provided by forecasts and measurement products provided as retrieved observations.

Descriptors for the representation of atmospheric constituents

ECMWF is requested to clarify whether the cloud amount could be expressed directly in percentage.

1. Measured or physical quantities

Table Reference	**Element name**	**BUFR**				
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	Status
0 15 007	Molecular mass	u (unified atomic mass unit)	2	0	15	Validation
0 15 008	Scaled volumetric mixing ratio	numeric	0	0	10	Validation
0 15 009	Scaled integrated number density	m^{-2}	0	0	10	Validation
0 15 010	Scaled partial pressure	Pa	0	0	10	Validation

0 15 021	Scaled integrated mass density	kg/m^2	0	0	10	Validation
0 15 022	Scaled number density	m^{-3}	0	0	10	Validation
0 15 023	Scaled mass density	kg/m^3	0	0	10	Validation
0 15 024	Optical depth	numeric	4	0	24	Validation
0 15 029	Scaled extinction coefficient	m^{-1}	0	0	10	Validation
0 15 028	Photo dissociation rate	s^{-1}	0	0	10	Validation
0 15 042	Reflectance	Numeric	6	0	20	Validation
0 15 043	No. of averaging kernel layers	Numeric	0	0	10	Validation
0 15 044	Averaging kernel value	Numeric	6	$-5E10^6$	24	Validation

Note : Scaled descriptors should be preceded by descriptor 0 08 090 which indicates the decimal magnitude of the scaled value. See note concerning descriptor 0 08 090 for further details.

2. Coordinates

Table Reference	**Element name**	**BUFR**				
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	Status
0 07 011	Scaled pressure	Pa	0	0	14	Validation

3. Instrumentation

Table Reference	**Element name**	**BUFR**				
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	Status
0 02 071	Spectrographic wavelength	M	13	0	30	Validation
0 02 072	Spectrographic width	M	13	0	30	Validation

4. Significance qualifier

Table Reference	Element name	BUFR				
F X Y		Unit	Scale	Ref. value	Data width (bits)	Status
0 08 043	Atmospheric chemical or physical constituent type	Code Table	0	0	8	Validation
0 08 044	CAS registry number	CCITT IA5	0	0	88	Validation
0 08 045	Particulate matter characterization	Code Table	0	0	8	Validation
0 08 026	Matrix significance	Code Table	0	0	6	Validation
0 08 027	Matrix geometry	Code Table	0	0	6	Validation
0 08 090	Decimal scale of following values	Numeric	0	-127	8	Validation

Note 1: Descriptor 0 08 090 is to be used to establish the decimal scale of one or more subsequent numerical element descriptors requiring a large dynamic range of values. The numerical element descriptor(s) will contain the scaled value of the measurement(s) with the required number of significant digits. The actual value will be obtained, at the application level, by multiplying the scaled value by the given decimal scale : (scaled value * $10^{\text{decimal scale}}$).

Note 2: When descriptor 0 08 043 is used to specify particulate matter under a given size threshold, descriptor 0 08 045 may also be used to further specify a subset of the PM population on the basis of ion composition.

5. Observed phenomena

Table Reference	Element name	BUFR				
F X Y		Unit	Scale	Ref. value	Data width (bits)	Status
0 20 079	Snow/Ice crystals indicator	Flag Table	0	0	2	Validation
0 20 080	Cloud amount percentage interval	Code table	0	0	3	Validation

6. Processing information

Table Reference	Element name	BUFR				
F X Y		Unit	Scale	Ref. value	Data width (bits)	Status
0 25 143	Linear coefficient	Numeric	6	$-5*10^6$	24	Validation
0 25 144	Matrix dimension (i axis)	Numeric	0	0	9	Validation
0 25 145	Matrix dimension (j axis)	Numeric	0	0	9	Validation

Note: Descriptor 0 25 143 is intended for numerical, non-dimensional values to be used as coefficients in statistical or linear processing. Each instance of 0 25 143 should be characterized by using an appropriate significance qualifier, such as 0 08 026.

CODE TABLES

Code table 0 08 043

The last column in the table contains the associated registry number from the Chemical Abstracts Service (CAS) of the American Chemical Society.

Code figure	*Meaning*		
	Name	*Formula*	*CAS Number (if applicable)*
0	Ozone	O_3	10028-15-6
1	Water vapour	H_2O	7732-18-5
2	Methane	CH_4	74-82-8
3	Carbon dioxide	CO_2	37210-16-5
4	Carbon monoxide	CO	630-08-0
5	Nitrogen dioxide	NO_2	10102-44-0
6	Nitrous oxide	N_2O	10024-97-2
7	Formaldehyde	HCHO	50-00-0
8	Sulfur dioxide	SO_2	7446-09-5
09-24	reserved		

	Meaning		
25	Particulate Matter < 1.0 microns		
26	Particulate Matter < 2.5 microns		
27	Particulate Matter < 10 microns		
28	Aerosols (generic)		
29	Smoke (generic)		
30	Crustal Material (generic dust)		
31	Volcanic Ash		
32-200	reserved		
201-254	reserved for local use		
255	missing		

Code table 0 08 045

Code figure	***Meaning***
0	Particulate Matter (all types)
1	NO_3(-)
2	NH_4(+)
3	Na(+)
4	Cl(-)
5	Ca(2+)
6	Mg(2+)
7	K(+)
8	SO_4(2-)
9-200	reserved
201-254	reserved for local use
255	missing

Code table 0 08 026

Code figure	*Meaning*
0	Averaging kernel matrix
1	Correlation matrix (C)
2	Lower triangular correlation matrix square root (L from $C=LL^T$)
3	Inverse of lower triangular correlation matrix square root (L^{-1})
4-42	Reserved
43-62	Reserved for local use
63	Missing or undefined significance

Code table 0 08 027

Code figure	*Meaning*
0	Assume no particular matrix geometry
1	Diagonal matrix
2	Tridiagonal matrix
3	Multi-diagonal matrix (general case: diagonal and above)
4	Lower triangular matrix
5	Symmetrical matrix
6-42	Reserved
43-62	Reserved for local use
63	Missing

Flag table 0 20 079

Bit No.	*Meaning*
1	Snow or ice crystals present
All 2	Missing value

Code table 0 20 080

Code figure	***Meaning***
0	0-25% cloudy pixels
1	25-50% cloudy pixels
2	50-75% cloudy pixels
3	75-100% cloudy pixels
5-6	Reserved
7	Missing value

Example sequence for matrix representation:

Descriptor	Value	Unit	Meaning	Comment
0 08 026	0	Code Table	Matrix significance (0 = averaging kernel)	This descriptor characterizes subsequent data as being averaging kernel coefficients.
0 08 027	3	Code Table	Matrix geometry (3 = multidiagonal)	Descriptor characterizes subsequent data as belonging to a matrix of specified geometry
1 03 Y	Y=Number of rows		Repeat following two descriptors Y times ; 0 31 001 gets ignored (see note to regulation 94.5.4.1).	The use of plain replication here supposes we know the size of the matrix and it does not change from observation to observation.
1 01 000			Delayed replication x descriptors	
0 31 001			Delayed replication count	This is where to look for the count for the number of incoming values in the current row of the matrix.
0 25 143	unitless coefficient.	Numeric	Data to be inserted in reconstructed matrix at receiving end.	Our understanding of the matrix geometry should often be sufficient to allow us to skip the values that are zero by construction. However nothing in this sequence prevents us from sending every value, including the zeroes.
0 08 027	63	Code Table	63 = missing	Cancel the significance qualifier
0 08 026	63	Code Table	63 = missing	Cancel the significance qualifier and sequence

ANNEX TO PARAGRAPH 3.2.2

Pre-operational

Add the following new entry to BUFR/CREX Class 15):

TABLE REFERENCE			TABLE ELEMENT NAME	BUFR				CREX		
F	X	Y		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0	15	027	Concentration of pollutant	Kg m^{-3}	9	0	10	Kg m^{-3}	9	4

In addition, and on a related note, we would like to point out the following typographical errors in the English translation of the current WMO Manual 306, Part B for BUFR/CREX Class 15:

- *For both 0-15-025 and 0-15-026, the "ELEMENT NAME" contains the word "pollutant" misspelled as "polluant".*

The units of 0-15-026 should be "mol mol^{-1}" (i.e. one included space) rather than "$molmol^{-1}$", which seems to imply the reciprocal of some heretofore unknown unit of measure!

ANNEX TO PARAGRAPH 3.3.2

Pre-operational

Part I

New entries indicated in blue are proposed for addition in code/flag table 002038

0 02 038

Method of water temperature and/or salinity measurement

Code Figure	
0	Ship intake
1	Bucket
2	Hull contact sensor
3	Reversing Thermometer
4	STD/CTD sensor
5	Mechanical BT
6	Expendable BT
7	Digital BT
8	Thermistor chain
9	Infra-red scanner
10	Micro-wave scanner
11	Infrared radiometer
12	In line thermosalinograph
13	Towed body
14	Other
15	Missing value

Part II

Proposed new descriptor for Depth below sea water surface (High resolution)

TABLE REFERENCE			TABLE ELEMENT NAME	BUFR				CREX		
				UNIT	SCALE	REF. VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Charac.)
F	X	Y								
0	07	063	Depth below sea/water surface	m	2	0	20	m	2	7

Part III

Changed sequence 3 02 056

3 02 056		**Sea Surface Temperature, method of measurement, and depth**
	0 02 038	Method of sea surface temperature measurement
	0 07 063	Depth below sea water surface (High resolution) (for sea surface temperature measurement)
	0 22 043	Sea/water temperature **$s_sT_wT_wT_w$**
	0 07 063	Depth below sea water surface (High resolution) (of sensor) (set to missing to cancel the previous value)

ANNEX TO PARAGRAPH 3.4.1

Operational

Add the following new entries to BUFR/CREX Class 0:

0 00 004	**BUFR/CREX Master Table (see Note (2))**	**CCITT IA5 Character**	**0 0**	**0**	**16 2**
0 00 006	**BUFR Master Table Version Number (see Note (3))**	**CCITT IA5 Character**	**0 0**	**0**	**16 2**
0 00 007	**CREX Master Table Version Number (see Note (4))**	**CCITT IA5 Character**	**0 0**	**0**	**16 2**
0 00 008	**BUFR Local Table Version Number (see Note (5))**	**CCITT IA5 Character**	**0 0**	**0**	**16 2**

Add the following new notes to BUFR/CREX Class 0:

(2) Master Tables are described in Note (2) to Section 1 of the BUFR regulations.
(3) BUFR Master Table Version Numbers are described in Notes (2) and (4) to Section 1 of the BUFR regulations for edition 3, and in Notes (2) and (5) to Section 1 of the BUFR regulations for edition 4.
(4) CREX Master Table Version Numbers are described in Note (1) to Section 1 of the CREX regulations.
(5) Local Table version number (see Note (2) to Section 1 of the BUFR regulations

Revise Note (2) under Section 1 of the BUFR regulations (for both editions 3 and 4) to read:

A BUFR master table may be defined for a scientific discipline other than meteorology. This shall be indicated by a non-zero numeric value in octet 4. Such a table will be developed, in coordination with the ET/DR+C, when a recognized organization exists with the necessary expertise to maintain such a master table, and when at least one of the following situations also exists:

- Requirements cannot be met using Master Table 0.
- There is expected to be a minimal amount of overlap with respect to the entries in Master Table 0.

The current list of master tables, along with their associated values in octet 4, is as follows:

0 Meteorology maintained by World Meteorological Organization (WMO)
10 Oceanography maintained by International Oceanographic Commission (IOC)

Whenever a new master table is developed, the following criteria shall apply:

- Table C may not be changed, nor may Classes 00 and 31 of Table B. These would remain identical for any of the master tables.
- For Classes 01 through 09 (coordinate classes) and Class 33 of Table B, and for Categories 00 and 01 of Table D, these Classes and Categories must have the same name and be used for the same types of descriptors as in Master Table 0; however, individual descriptors within these Classes and Categories would be left to the discretion of the organization defining the particular master table in question.
- For Table A and all remaining Classes of Table B and Categories of Table D, these would be left to the discretion of the organization defining the particular master table in question.

For all master tables (including Master Table 0):

— Each revision of the master table shall be given a new version number.
— Local tables shall define those parts of the master table which are reserved for local use, thus version numbers of local tables may be changed at will by the originating centre.

<u>Revise octet 11 under Section 1 of the BUFR regulations for edition 3 to read:</u>

11 Version number of master table used – see Notes (2) and (4)

<u>Revise octet 14 under Section 1 of the BUFR regulations for edition 4 to read:</u>

14 Version number of master table used – see Notes (2) and (5)

<u>Add the following as new Note (4) under Section 1 of the BUFR regulations for edition 3 (and as new Note (5) for edition 4):</u>

For Master Table 0, the master table version numbers are as follows:

0	Experimental
1	Version implemented on 1 November 1988
2	Version implemented on 1 November 1993
3	Version implemented on 2 November 1994
4	Version implemented on 8 November 1995
5	Version implemented on 6 November 1996
6	Version implemented on 5 November 1997
7	Version implemented on 4 November 1998
8	Version implemented on 3 May 2000
9	Version implemented on 8 November 2000
10	Version implemented on 7 November 2001
11	Version implemented on 5 November 2003
12	Version implemented on 2 November 2005
13	Pre-operational to be implemented by next amendment

Change vv definition in CREX Section 1 Edition 1 and Edition 2 to:
vv: CREX Master Table version number (see Note 1)

Change bb definition in CREX Section 1 Edition 2 to:
bb: BUFR Master Table version number (see Note (5) under Section 1 of the BUFR regulations for Edition 4)

<u>Add the following as new Note (1) under Section 1 of the CREX regulations:</u>

For Master Table 0, the master table version numbers are as follows:

0	Experimental
1	Version implemented on 3 May 2000
2	Version implemented on 7 November 2001
3	Version implemented on 4 November 2003
4	Version implemented on 2 November 2005
5	Pre-operational to be implemented by next amendment

ANNEX TO PARAGRAPH 3.4.2

Preoperational

Proposal for new code table entries

1 MHS

The MHS instrument replaces the AMSU-B instrument in the ATOVS package operated by EUMETSAT and NOAA. The level 1b data from the MHS can be represented in BUFR using exactly the same sequence of descriptors, which was used for AMSU-B.

The following changes are required to standardize the representation of MHS data:

Code Table 0-02-048

Add:	11, Parameter = MHS
Change:	11 to 14, Parameter = Reserved
to:	12 to 14, Parameter = Reserved

Code Table 0-02-150

Change:	43, Parameter = AMSU-B 1
to:	43, Parameter = AMSU-B 1 / MHS 1
Change:	44, Parameter = AMSU-B 2
to:	44, Parameter = AMSU-B 2 / MHS 2
Change:	45, Parameter = AMSU-B 3
to:	45, Parameter = AMSU-B 3 / MHS 3
Change:	46, Parameter = AMSU-B 4
to:	46, Parameter = AMSU-B 4 / MHS 4
Change:	47, Parameter = AMSU-B 5
to:	47, Parameter = AMSU-B 5 / MHS 5

Code Table 0-02-151

Add:	9, Parameter = MHS
Change:	8 to 2046, Parameter = Reserved
to:	10 to 2046, Parameter = Reserved

Sequence Descriptor 3-10-010

Change:	Title = "ATOVS AMSU-B report"
to:	Title = "ATOVS AMSU-B / MHS report"

2. IASI

The IASI instrument is a hyperspectral sounder, which will fly on the Metop spacecraft operated by EUMETSAT. The level 1c data from IASI will be exchanged in BUFR. The details of the representation of the data have been discussed by many parties (ECMWF, UK Met Office, NOAA, MeteoFrance, DWD) in great detail and presented at several international meetings (including the 14th International TOVS Study Conference in Beijing). Synthetic IASI data are being generated in near real time by NOAA using the descriptors proposed here. These data have been successfully encoded and decoded by independent software.

The new element and sequence descriptors given here are from the range of local values and are shown in parentheses. It is proposed to assign descriptors from Classes and Categories 40, 41 and 42 of BUFR Tables B and D.

The following changes are required to standardize the representation of IASI data:

New Sequence Descriptor (3-40-001): " IASI Level 1c data"

0-01-007	Satellite identifier
0-01-031	Identification of originating/generating centre
0-02-019	Satellite instruments
0-02-020	Satellite classification
0-04-001	Year
0-04-002	Month
0-04-003	Day
0-04-004	Hour
0-04-005	Minute
2-02-131	Add 3 to scale
2-01-138	Add 10 to width
0-04-006	Second
2-01-000	Reset width
2-02-000	Reset scale
0-05-001	Latitude (high accuracy)
0-06-001	Longitude (high accuracy)
0-07-024	Satellite zenith angle
0-05-021	Bearing or azimuth
0-07-025	Solar zenith angle
0-05-022	Solar azimuth
0-05-043	Field of view number
0-05-040	Orbit number
2-01-133	Add 5 to width
0-05-041	Scan line number
2-01-000	Reset width
2-01-132	Add 4 to width
0-25-070	Major frame count
2-01-000	Reset width
2-02-126	Subtract 2 from scale
0-07-001	Height of station
2-02-000	Reset scale
(0-33-060)	GQisFlagQual
(0-33-061)	QGisQualIndex
(0-33-062)	QGisQualIndexLoc
(0-33-063)	QGisQualIndexRad
(0-33-064)	QGisQualIndexSpect
(0-33-065)	GQisSysTecSondQual
1-01-010	Repeat next 1 descriptor 10 times
(3-40-002)	IASI Level 1c band description
1-01-087	Repeat next 1 descriptor 87 times
(3-40-003)	IASI Level 1c 100 channel sequence
0-02-019	Satellite instruments
0-25-051	AVHRR channel combination
1-01-007	Repeat next 1 descriptor 7 times
(3-40-004)	IASI Level 1c AVHRR single scene sequence

New Sequence Descriptor: (3-40-002) "IASI Level 1c band description"

(0-25-140)	Start channel
(0-25-141)	End channel
(0-25-142)	Channel scale factor

New Sequence Descriptor: (3-40-003) " IASI Level 1c 100 channel sequence"

1-04-100	Repeat next 4 descriptor 100 times
2-01-136	Add 8 to width

0-05-042 Channel number
2-01-000 Reset width
(0-14-046) Scaled IASI radiance

New Sequence Descriptor: (3-40-004) " IASI Level 1c AVHRR single scene sequence"

(0-05-060) Y angular position from centre of gravity
(0-05-061) Z angular position from centre of gravity
0-25-085 Fraction of clear pixels in HIRS FOV
1-05-006 Repeat next 5 descriptor 6 times
0-05-042 Channel number
(0-25-142) Channel scale factor
(0-14-047) Scaled mean AVHRR radiance
(0-25-142) Channel scale factor
(0-14-048) Scaled std dev AVHRR radiance

New Element Descriptors:

Descriptor	Name	Units	Scale	Reference	Width
(0-05-060)	Y angular position from centre of gravity	Degree	6	-8000000	24
(0-05-061)	Z angular position from centre of gravity	Degree	6	-8000000	24
(0-14-046)	Scaled IASI radiance	$Wm^{-2}sr^{-1}m^{-1}$	0	-5000	16
(0-14-047)	Scaled mean AVHRR radiance	$Wm^{-2}sr^{-1}m^{-1}$	0	0	31
(0-14-048)	Scaled std dev AVHRR radiance	$Wm^{-2}sr^{-1}m^{-1}$	0	0	31
(0-25-140)	Start channel	Numeric	0	0	14
(0-25-141)	End channel	Numeric	0	0	14
(0-25-142)	Channel scale factor	Numeric	0	0	6
(0-33-060)	GqisFlagQual - individual IASI-System quality flag	Code Table	0	0	2
(0-33-061)	GqisQualIndex - indicator for instrument noise performance (contributions from spectral and radiometric)	%	0	0	7
(0-33-062)	GqisQualIndexLoc - indicator for geometric quality index	%	0	0	7
(0-33-063)	GqisQualIndexRad - indicator for instrument noise performance (contributions from radiometric calibration)	%	0	0	7
(0-33-064)	GqisQualIndexSpect - indicator for instrument noise performance (contributions from spectral calibration)	%	0	0	7
(0-33-065)	GqisSysTecSondQual - output of system TEC (Technical Expertise Centre) quality function	Numeric	0	0	24

New Code Table (0-33-060) "GQisFlagQual - individual IASI-System quality flag"

0, Parameter = Good
1, Parameter = Bad
2, Parameter = Reserved
3, Parameter = Missing

An offset has been introduced for the scaled IASI radiances (0-14-046). This is to accommodate the negative radiances which can be measured at some wave numbers, either due to effects of noise or remaining after apodisation. The offset is an order of magnitude larger than the expected maximum negative excursion based on instrument noise, and so would leave sufficient margin. At the same time the dynamic range is not significantly degraded.

3 ASCAT

EUMETSAT will produce level 1b ASCAT products at its headquarters in Darmstadt, Germany. These data will be encoded in BUFR and disseminated via EUMETCast (DVB satellite multicast service) and on the GTS. EUMETSAT's Ocean and Sea Ice Satellite Application Facility (OSI-SAF), hosted by KNMI, will produce level 2 products from the level 1b data. It is also foreseen to add soils moisture to the level 2 ASCAT product in the future.

The new element and sequence descriptors given here have been developed by close co-operation between EUMETSAT, the OSI-SAF and the ASCAT Science Advisory Group (SAG). The proposed sequence will accommodate both the level 1b and the level 2 data simultaneously. When the level 1b data leave EUMETSAT, the parts of the sequence relating to level 2 processing will be set to "missing". This approach will allow users to ingest the same sequence, whether they are receiving level 1b data or level 2 data.

The new element and sequence descriptors are from the range of local values and are shown in parentheses. It is proposed to assign descriptors from Classes and Categories 40, 41 and 42 of BUFR Tables B and D within Master Tables 0, as per Section 3.5 of the Final Report of the 2004 meeting of the ET/DR&C.

The following changes are required to standardize the representation of ASCAT data:

New Sequence Descriptor: (3-12-061) "ASCAT Level 1b and level 2 data sequence"

(3-12-058)	ASCAT level 1b data
(3-12-060)	Scatterometer soil moisture data
(3-12-059)	Scatterometer wind data

New Sequence Descriptor: (3-12-058) "ASCAT level 1b data sequence"

(3-01-125)	ASCAT header information
3-01-011	Date information
3-01-013	Time information
3-01-021	Position information
(3-12-055)	ASCAT level 1b cell information
(0-21-150)	Beam co-location
1-01-003	Repeat next 1 descriptor 3 times
(3-21-030)	ASCAT sigma-0 information

New Sequence Descriptor: (3-12-060) "Scatterometer soil moisture data sequence"

0-25-060	Software identification
(0-25-062)	Database identification
(0-40-001)	Surface soil moisture (ms)
(0-40-002)	Estimated error in surface soil moisture
0-21-062	Extrapolated backscatter at 40deg incidence angle (sigma0_40)

(0-21-151)	Estimated error in sigma0 at 40deg incidence angle
(0-21-152)	Slope at 40deg incidence angle
(0-21-153)	Estimated error in slope at 40deg incidence angle
(0-21-154)	Soil moisture sensitivity
0-21-062	Dry backscatter
(0-21-088)	Wet backscatter
(0-40-003)	Mean surface soil moisture
(0-40-004)	Rain fall detection
(0-40-005)	Soil moisture correction flag
(0-40-006)	Soil moisture processing flag
(0-40-007)	Soil moisture quality
0-20-065	Snow cover
(0-40-008)	Frozen land surface fraction
(0-40-009)	Inundation and wetland fraction
(0-40-010)	Topographic complexity

New Sequence Descriptor: (3-12-059) "Scatterometer wind data sequence"

(3-12-056)	Scatterometer wind cell information
1-01-000	Delayed replication of next 1 descriptor
0-31-001	Delayed replication factor
(3-12-057)	Ambiguous wind data

New Sequence Descriptor: (3-01-125) "ASCAT header information sequence"

0-01-033	Identification of originating/generating centre
0-01-034	Identification of originating/generating sub-centre
0-25-060	Software identification
0-01-007	Satellite identifier
0-02-019	Satellite instruments
0-01-012	Direction of motion of moving observing platform

New Sequence Descriptor: (3-12-055) " ASCAT level 1b cell information"

0-05-033	Pixel size on horizontal-1
0-05-040	Orbit number
0-06-034	Cross track cell number
(0-10-095)	Height of atmosphere used
(0-21-157)	Loss per unit length of atmosphere used

New Sequence Descriptor: (3-21-030) "ASCAT sigma-0 information"

(0-08-085)	Beam identifier
2-02-129	Increase scaling by 10^1
2-01-131	Increase data width by 3 bits
0-02-111	Radar incidence angle
2-01-000	Cancel change data width
2-02-000	Cancel change scaling
0-02-134	Antenna beam azimuth
0-21-062	Backscatter
0-21-063	Radiometric resolution (noise value)
(0-21-158)	ASCAT kp estimate quality
(0-21-159)	ASCAT sigma-0 usability

(0-21-160) ASCAT synthetic data quality
(0-21-161) ASCAT synthetic data quantity
(0-21-162) ASCAT satellite orbit and attitude quality
(0-21-163) ASCAT solar array reflection contamination
(0-21-164) ASCAT telemetry presence and quality
(0-21-165) ASCAT extrapolated reference function
(0-21-166) ASCAT land fraction

New Sequence Descriptor: (3-12-056) "Scatterometer wind cell information sequence"

0-25-060 Software identification
0-01-032 Generating application
0-11-082 Model wind speed at 10 m
0-11-081 Model wind direction at 10 m
(0-20-095) Ice probability
(0-20-096) Ice age (a-parameter)
(0-21-155) Wind vector cell quality
2-01-133 Increase data width by 5 bits
0-21-101 Number of vector ambiguities
0-21-102 Index of selected wind vector
2-01-000 Cancel change data width

New Sequence Descriptor: (3-12-057) "Ambiguous wind data"

2-01-130 Increase data width by 2 bits
2-02-129 Increase scaling by 10^1
0-11-012 Wind speed at 10 m
2-02-000 Cancel change scaling
2-01-000 Cancel change data width
2-01-131 Increase data width by 3 bits
2-02-129 Increase scaling by 10^1
0-11-011 Wind direction at 10 m
2-02-000 Cancel change scaling
2-01-000 Cancel change data width
(0-21-156) Backscatter distance
0-21-104 Likelihood computed for solution

New Element Descriptors:

Descriptor	Name	Units	Scale	Reference	Width
(0-10-095)	Height of atmosphere used	m	0	0	16
(0-08-085)	Beam identifier	Code table	0	0	3
(0-20-095)	Ice probability	Numeric	3	0	10
(0-20-096)	Ice age ("A" parameter)	dB	2	-4096	13
(0-21-088)	Wet backscatter	dB	2	-5000	13
(0-21-150)	Beam collocation	Code table	0	0	2
(0-21-151)	Estimated error in sigma0 at 40deg incidence angle	dB	2	0	9
(0-21-152)	Slope at 40deg incidence angle	dB/Deg	2	-80	7
(0-21-153)	Estimated error in slope at 40deg incidence angle	dB/Deg	2	-40	6
(0-21-154)	Soil moisture sensitivity	dB	2	0	12
(0-21-155)	Wind vector cell quality	Flag table	0	0	24

(0-21-156)	Backscatter distance	Numeric	1	-4096	13
(0-21-157)	Loss per unit length of atmosphere used	dB m-1	10	0	22
(0-21-158)	ASCAT kp estimate quality	Code table	0	0	2
(0-21-159)	ASCAT sigma-0 usability	Code table	0	0	2
(0-21-160)	ASCAT use of synthetic data	Numeric	3	0	10
(0-21-161)	ASCAT synthetic data quality	Numeric	3	0	10
(0-21-162)	ASCAT satellite orbit and attitude quality	Numeric	3	0	10
(0-21-163)	ASCAT solar array reflection contamination	Numeric	3	0	10
(0-21-164)	ASCAT telemetry presence and quality	Numeric	3	0	10
(0-21-165)	ASCAT extrapolated reference function presence	Numeric	3	0	10
(0-21-166)	ASCAT land fraction	Numeric	3	0	10
(0-25-062)	Database identification	Numeric	0	0	14
(0-40-001)	Surface soil moisture (ms)	%	1	0	10
(0-40-002)	Estimated error in surface soil moisture	%	1	0	10
(0-40-003)	Mean surface soil moisture	Numeric	3	0	10
(0-40-004)	Rain fall detection	Numeric	3	0	10
(0-40-005)	Soil moisture correction flag	Flag table	0	0	8
(0-40-006)	Soil moisture processing flag	Flag table	0	0	16
(0-40-007)	Soil moisture quality	%	1	0	10
(0-40-008)	Frozen land surface fraction	%	1	0	10
(0-40-009)	Inundation and wetland fraction	%	1	0	10
(0-40-010)	Topographic complexity	%	1	0	10

New Code Table (0-08-085) "Beam identified"

0,	Parameter = Fore beam
1,	Parameter = Mid beam
2,	Parameter = Aft beam
3 to 6,	Parameter = Reserved
7,	Parameter = Missing

New Code Table (0-21-150) "Beam co-location"

0,	Parameter = Data from single ground station (no co-location)
1,	Parameter = Data from multiple ground station (co-located data)
2,	Parameter = Reserved
3,	Parameter = Missing

New Flag Table (0-21-155) "Wind vector cell quality"

Bit 1:	Not enough good sigma-0 available for wind retrieval
Bit 2:	Poor azimuth diversity among sigma-0 for wind retrieval
Bit 3:	Any beam noise content above threshold
Bit 4:	Product monitoring not used
Bit 5:	Product monitoring flag
Bit 6:	KNMI quality control fails
Bit 7:	Variational quality control fails
Bit 8:	Some portion of wind vector cell is over land
Bit 9:	Some portion of wind vector cell is over ice

Bit 10:	Wind retrieval not performed for wind vector cell
Bit 11:	Reported wind speed is greater than 30 m/s
Bit 12:	Reported wind speed is less than or equal to 3 m/s
Bit 13:	Rain flag for the wind vector cell is not usable
Bit 14:	Rain flag algorithm detects rain
Bit 15:	No meteorological background used
Bit 16:	Data are redundant
Bit 17-23:	Reserved
All 24:	Missing

New Code Table (0-21-158) "ASCAT KP quality estimate"

0,	Parameter = Acceptable
1,	Parameter = Not acceptable
2,	Parameter = Reserved
3,	Parameter = Missing

New Code Table (0-21-159) "ASCAT sigma-0 usability"

0,	Parameter = Good
1,	Parameter = Usable
2,	Parameter = Bad
3,	Parameter = Missing

New Flag Table (0-40-005) "Soil moisture correction flags"

Bit 1:	Soil moisture between -20% and 0%
Bit 2:	Soil moisture between 100% and 120%
Bit 3:	Correction of wet backscatter reference
Bit 4:	Correction of dry backscatter reference
Bit 5:	Correction of volume scattering in sand
Bits 6-7:	Reserved
All 8:	Missing

New Flag Table (0-40-006) "Soil moisture processing flags"

Bit 1:	Not soil
Bit 2:	Sensitivity to soil moisture below limit
Bit 3:	Azimuthal noise above limit
Bit 4:	Backscatter Fore-Aft beam out of range
Bit 5:	Slope Mid-Fore beam out of range
Bit 6:	Slope Mid-Aft beam out of range
Bit 7:	Soil moisture below -20%
Bit 8:	Soil moisture above 120%
Bits 9-16:	Reserved

Code Table 0-02-048

Add:	12, Parameter = ASCAT
Change:	12 to 14, Parameter = Reserved
to:	13 to 14, Parameter = Reserved

ANNEX TO PARAGRAPH 3.4.3

Pre-operational

Proposed Table D descriptors which correspond with whole sequences of RADOB, TRACKOB and SAREP

1. RADOB Template (part A: Information on tropical cyclone)

3 16 050	3 01 001	WMO block and station number
	3 01 011	Date
	3 01 012	Time
	0 02 160	Wave length of the radar
	0 08 005	Meteorological attribute significance (=1)
	0 05 002	Latitude (coarse accuracy)
	0 06 002	Longitude (coarse accuracy)
	0 08 005	Cancel Meteorological attribute significance
	0 19 100	Time interval to calculate the movement of the tropical cyclone
	0 19 005	Direction of motion of feature
	0 19 006	Speed of motion of feature
	0 19 101	Accuracy of the position of the centre of the tropical cyclone
	0 19 102	Shape and definition of the eye of the tropical cyclone
	0 19 103	Diameter of major axis of the eye of the tropical cyclone
	0 19 104	Change in character of the eye during the 30 minutes
	0 19 105	Distance between the end of spiral band and the centre

2. TRACKOB Template

<u>BUFR template</u>

3 08 010	0 01 011	Ship or mobile land station identifier
	1 13 000	Delayed replication of 13 descriptors
	0 31 001	Delayed descriptor replication factor
	3 01 011	Date
	3 01 012	Time
	3 01 021	Latitude/Longitude (course accuracy)
	0 04 080	Averaging period for following value
	0 22 049	Sea surface temperature
	0 04 080	Averaging period for following value
	0 22 059	Sea surface salinity
	0 04 080	Averaging period for following value
	0 22 005	Direction of sea surface current
	0 02 042	Indicator for sea surface current speed
	0 22 032	Speed of sea surface current
	0 02 042	Indicator for sea surface current speed (cancel)
	0 04 080	Averaging period for following value (cancel)

CREX template

D 08 010	B 01 011	Ship or mobile land station identifier
	R 13 000	Delayed replication of 13 descriptors
	D 01 011	Date
	D 01 012	Time
	D 01 021	Latitude/Longitude (course accuracy)
	B 04 080	Averaging period for following value
	B 22 049	Sea surface temperature
	B 04 080	Averaging period for following value
	B 22 059	Sea surface salinity
	B 04 080	Averaging period for following value
	B 22 005	Direction of sea surface current
	B 02 042	Indicator for sea surface current speed
	B 22 032	Speed of sea surface current
	B 02 042	Indicator for sea surface current speed (cancel)
	B 04 080	Averaging period for following value (cancel)

3. SAREP Template (part A: Information on tropical cyclone)

BUFR template

3 16 052	3 01 005	Originating centre/sub-centre
	3 01 011	Date
	3 01 012	Time
	0 01 007	Satellite identifier
	0 25 150	Satellite intensity analysis method of tropical cyclone
	1 22 000	Delayed replication of 22 descriptors
	0 31 001	Delayed descriptor replication factor
	0 01 027	WMO long storm name
	0 19 150	Typhoon International Common Number (Typhoon Committee)
	0 19 106	Identification number of tropical cyclone
	0 08 005	Meteorological attribute significance (=1)
	0 05 002	Latitude (coarse accuracy)
	0 06 002	Longitude (coarse accuracy)
	0 08 005	Cancel Meteorological attribute significance
	0 19 107	Time interval of the tropical cyclone analysis
	0 19 005	Direction of motion of feature
	0 19 006	Speed of motion of feature
	0 19 108	Accuracy of geographical position of the tropical cyclone
	0 19 109	Mean diameter of the overcast cloud of the tropical cyclone
	0 19 110	Apparent 24-hour change in intensity of the tropical cyclone
	0 19 111	Current Intensity (CI) number of the tropical cyclone
	0 19 112	Data tropical (DT) number of the tropical cyclone
	0 19 113	Cloud pattern type of the DT-number

	0 19 114	Model Expected tropical (MET) number of the tropical cyclone
	0 19 115	Trend of the past 24-hour change (+: Developed, -: Weakened)
	0 19 116	Pattern tropical (PT) number of the tropical cyclone
	0 19 117	Cloud picture type of the PT-number
	0 19 118	Final tropical (T) number of the tropical cyclone
	0 19 119	Type of the final T-number

<u>CREX template</u>

D 16 052	D 01 005	Originating centre/sub-centre
	D 01 011	Date
	D 01 012	Time
	B 01 007	Satellite identifier
	B 25 150	Satellite intensity analysis method of tropical cyclone
	R 22 000	Delayed replication of 22 descriptors
	B 01 027	WMO long storm name
	B 19 150	Typhoon International Common Number (Typhoon Committee)
	B 19 106	Identification number of tropical cyclone
	B 08 005	Meteorological attribute significance (=1)
	B 05 002	Latitude (coarse accuracy)
	B 06 002	Longitude (coarse accuracy)
	B 08 005	Cancel Meteorological attribute significance
	B 19 107	Time interval of the tropical cyclone analysis
	B 19 005	Direction of motion of feature
	B 19 006	Speed of motion of feature
	B 19 108	Accuracy of geographical position of the tropical cyclone
	B 19 109	Mean diameter of the overcast cloud of the tropical cyclone
	B 19 110	Apparent 24-hour change in intensity of the tropical cyclone
	B 19 111	Current Intensity (CI) number of the tropical cyclone
	B 19 112	Data tropical (DT) number of the tropical cyclone
	B 19 113	Cloud pattern type of the DT-number
	B 19 114	Model Expected tropical (MET) number of the tropical cyclone
	B 19 115	Trend of the past 24-hour change (+: developed, -: weakened)
	B 19 116	Pattern tropical (PT) number of the tropical cyclone
	B 19 117	Cloud picture type of the PT-number
	B 19 118	Final tropical (T) number of the tropical cyclone
	B 19 119	Type of the final T-number

ANNEX TO PARAGRAPH 3.4.5.1

Preoperational

To represent any nominal value in BUFR a new descriptor in class 8 of the BUFR Table B is to be used to indicate the cause of nominal value.

Ref number	Name	Unit	Scale	Reference	Data width
008083	Nominal value indicator	Flag table	0	0	15

008083 Nominal value indicator

Bit No.	Meaning
1	Adjusted with respect to representative height of sensor above local ground (or Deck of marine platform)
2	Adjusted with respect to representative height of sensor above water surface
3	Adjusted with respect to standard surface roughness
4	Adjusted with respect to wind speed
5	Adjusted with respect to temperature
6	Adjusted with respect to pressure
7	Adjusted with respect to humidity
8	Adjusted with respect to evaporation
9	Adjusted with respect to wetting losses
10-14	Reserved
All 15	Missing value

The mechanism to represent any nominal value for any element in any BUFR template is by using 223000 Operator (substituted values follow).

223000	Substituted values follow
236000	Bit map follow
101000	Delayed replication operator
031001	Delayed replication
031031	Data present indicator
001033	Originating centre
001032	Originating application
008083	Nominal value indicator
101000	Delayed replication operator
031001	Delayed replication
223255	Substituted value marker operator

There may be one or more blocks similar as one above in the BUFR message. For an example the following block could follow in the case of re-using the bit map.

108000	Delayed replication operator
031001	Delayed replication
223000	Substituted values follow
237000	Use previously defined bit map
001033	Originating centre
001032	Originating application
008083	Nominal value indicator
101000	Delayed replication operator
031001	Delayed replication
223255	Substituted value marker operator

ANNEX TO PARAGRAPH 3.4.5.2

Operational - Editorial

Proposals

1 Addition of a Note under Class 20

Cloud cover (total) 0 20 010 is defined in BUFR/CREX Table B with UNIT = %. The corresponding Code table 2700 for N (Total cloud cover) in [1] allows to make a difference between N = 9 "Sky obscured by fog and/or other meteorological phenomena" and N = / (Cloud cover is indiscernible for reasons other than fog or other meteorological phenomena, or observation is not made). In the Regulations for reporting TAC data in TDCF, Cloud cover (total) 0 20 010 is recommended to be set to a missing value in both cases, which has been found not satisfactory.

It is proposed to add a Note under Class 20:
A cloud cover (total) value 113 shall indicate "Sky obscured by fog and/or other meteorological phenomena".

2 Addition of entry 62 in 0 08 002

In Regulation B/C 1.4.4.2 (e) for reporting SYNOP data in TDCF (and elsewhere), Vertical significance 0 08 002 is recommended to be set to "63 (Missing value)" if sky clear is observed. This might be confusing as the actual meaning is "not applicable".

It is proposed to add the code figure 62 in 0 08 002 to read:
62 Value not applicable.

3 Addition of another Note under Class 20

Bearing of ice edge 0 20 038 is defined in BUFR/CREX Table B with UNIT = Degree true. The Regulations for reporting SHIP data in TDCF require usage 0 20 038 set to 0, corresponding to the code figure 0 = "Ship in shore or flaw lead" in the Code table 0739 for D_i (True bearing of principal ice edge).

It is proposed to add a Note under Class 20:
A bearing of ice edge value 0 shall indicate "Ship in shore or flaw lead".

4 Minor modification of the previously proposed name of bit No.17 in Flag table 0 08 042

Document ET DR&C/Doc. 3.10(5) submitted to the ET DR&C meeting in Muscat, contained a proposal for three additions to Flag Table 0 08 042. All these new entries have been extensively used in the Regulations for reporting TEMP and PILOT type data and so it is proposed to introduce them into [2].

The name of bit No. 17 has been slightly modified as shown below.

Bit No.	0 08 042 - Extended vertical sounding significance
14	Top of wind sounding
15	Level determined by regional decision
17	**Pressure l**evel originally indicated by height as the vertical coordinate

ANNEX TO PARAGRAPH 3.4.5.3

Descriptors to be used when exchanging GHRSST data:

Table Reference	***Element name***	***BUFR***				***CREX***		
F X Y		***Unit***	***Scale***	***Ref. value***	***Data width (bits)***	***Unit***	***Scale***	***Data width (chars)***
0 25 037	SST bias	K	2	-127	8	K	2	3
0 14 035	Solar Radiation Flux	W/M2	1	0	14	W m^{-2}	1	5
0 25 022	GHRSST Rejection Flag	Flag table	0	0	9	Flag table	0	3
0 25 023	GHRSST Confidence Flag	Flag table	0	0	9	Flag table	0	3
0 25 024	GHRSST data quality.	Code table	0	0	4	Code table	0	2
0 01 028	Aerosol optical Depth (AOD) source	Code table	0	0	5	Code table	0	2
0 01 024	Wind Speed source	Code Table	0	0	5	Code Table	0	2
0 01 029	SSI Source	Code Table	0	0	5	Code Table	0	2
0 01 038	Source of Sea Ice Fraction	Code Table	0	0	5	Code Table	0	2
0 25 038	Difference between SST and analysis	K	1	-127	8	K	1	3
0 22 046	Sea Ice Fraction	Numeric	2	0	7	Numeric	2	3

Table 1. Proposed BUFR and CREX descritptors

0 25 022 - GHRSST Rejection Flag

Bit No.	
1	Unprocessed
2	Land suspected.
3	Wind speed too large
4	Ice detected.
5	Rain detected (Microwave retrievals only)
6	Cloudy detected (Infra-red retrievals only)
7	Cosmetic value
8	SST out of range
All 9	Missing value

0 25 023 - GHRSST Confidence Flag

Bit No.	
1	Default confidence value has been used.
2	Default bias and standard deviation has been used.
3	Sun glint suspected
4	Sea ice retrieval for microwave data
5	High wind speed retrieval

6	Inaccurate SST due to low SST (< 285K). (Only applies to the TMI instrument).
7	Relaxed rain contamination suspected
8	Potential side lobe contamination
All 9	Missing value

0 25 024 – GHRSST proximity confidence.

Code figure	
0	Unprocessed infrared retrieval
1	Cloudy retrievals.
2	Bad: Data that are probably contaminated by cloud.
3	Suspect data.
4	Acceptable data.
5	Excellent data.
6	Cool skin suspected.
7-9	Reserved
10	Unprocessed microwave retrieval.
11	Questionable microwave retrieval that may be contaminated.
12	Acceptable microwave retrieval.
13	High probability of diurnal variability.
14	Reserved
15	Missing value

0 01 028 - Aerosol optical Depth (AOD) source

Code figure	
0	No AOD data available
1	NESDIS
2	NAVOCEANO
3	NAAPS
4	MERIS
5	AATSR
6-30	Reserved for future use
31	Missing value

0 01 024 - Wind Speed source

Code figure	
0	No wind speed data available
1	AMSR-E data
2	TMI data
3	NWP: ECMWF
4	NWP: UK Met Office
5	NWP: NCEP
6	Reference climatology
7	ERS_Scatterometer
8-30	Reserved for future use
31	Missing value

0 01 029 - SSI Source

Code figure	
0	No SSI data available

1	MSG_SEVIRI
2	GOES East
3	GOES West
4	ECMWF
5	NCEP
6	UK Met Office
7-30	Reserved for future use
31	Missing value

0 01 038 - Source of Sea Ice Fraction

Code figure	
0	No sea ice set
1	NSIDC SSM/I Cavalieri et al (1992)
2	AMSR-E
3	ECMWF
4	CMS (France) cloud mask used by Medspiration
5	EUMETSAT OSI-SAF
6-30	Reserved for future use
31	Missing value

Table of Acronyms

Acronym	***Expansion***
AATSR	Advanced Along-Track Scanning Radiometer.
AMSR-E	Advanced Microwave Scanning Radiometer.
AOD	Aerosol optical depth.
BUFR	Binary Universal Form for the Representation of meteorological data.
CMS	Centre de Meteorologie Spatiale (Lannion, France).
CREX	Character form for the Representation and Exchange of meteorological and other data.
ECMWF	European Centre for Medium-range Weather Forecasts.
ERS	European Remote-sensing Satellite.
EUMETSAT	European organization for the exploitation of meteorological satellites.
GHRSST-PP	GODAE High Resolution Sea Surface Temperature Pilot Project.
GODAE	Global Ocean Data Assimilation Experiment.
GOES	Geostationary Operational Environment Satellite.
IR	Infra-red.
MERIS	Medium Resolution Imaging Spectrometer.
MSG	Meteosat Second Generation.
MW	Microwave.
NAAPS	Navy Aerosol Analysis and Prediction System.
NAVOCEANO	Naval Oceanographic Office (United States of America).
NCEP	National Centers for Environmental Prediction.
NESDIS	National Environmental Satellite, Data, and Information Service. (United States of America).
NWP	Numerical weather prediction.
OSI-SAF	Ocean and Sea Ice Satellite Applications Facility.
RF	Radio frequency.
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SSI	Surface Solar Irradiance.
TMI	Tropical Rainfall Measuring Mission (TRMM) Microwave Imager.

ANNEX TO PARAGRAPH 3.4.5.4

"MERGED" BUFR TEMPLATE FOR SURFACE OBSERVATIONS FROM ONE-HOUR PERIOD

This template is proposed to be used for representation of surface observation data from both automatic stations and manned stations. This template is also suitable for SYNOP observation data, by including parameters covering periods longer than one hour.
Descriptors used by both templates are not marked.
Descriptors used from the SYNOP BUFR template are indicated by an asterisk *.
Descriptors used from the AWS BUFR template are indicated by an asterisk *.

3 01 090		SYNOP	AWS	**Surface station identification; time, horizontal and vertical co-ordinates**	
3 01 004				**Surface station identification**	
	0 01 001			WMO block number	Numeric
	0 01 002			WMO station number	Numeric
	0 01 015			Station or site name	CCITT IA5
	0 02 001			Type of station	Code table
3 01 011	0 04 001			Year	Year
	0 04 002			Month	Month
	0 04 003			Day	Day
3 01 012	0 04 004			Hour	Hour
	0 04 005			Minute	Minute
3 01 021	0 05 001			Latitude (high accuracy)	Degree, scale 5
	0 06 001			Longitude (high accuracy)	Degree, scale 5
0 07 030				Height of station ground above mean sea level	m, scale 1
0 07 031				Height of barometer above mean sea level	m, scale 1
0 08 010				Surface qualifier (for temperature data)	Code table
3 01 091			*	***Surface station instrumentation***	
	0 02 180		*	*Main present weather detecting system*	*Code table*
	0 02 181		*	*Supplementary present weather sensor*	*Flag table*
	0 02 182		*	*Visibility measurement system*	*Code table*
	0 02 183		*	*Cloud detection system*	*Code table*
	0 02 184		*	*Type of lightning detection sensor*	*Code table*
	0 02 179		*	*Type of sky condition algorithm*	*Code table*
	0 02 186		*	*Capability to detect precipitation phenomena*	*Flag table*
	0 02 187		*	*Capability to detect other weather phenomena*	*Flag table*
	0 02 188		*	*Capability to detect obscuration*	*Flag table*
	0 02 189		*	*Capability to discriminate lightning strikes*	*Flag table*
				Pressure data	
3 02 001	0 10 004			Pressure	Pa, scale –1
	0 10 051			Pressure reduced to mean sea level	Pa, scale –1
	0 10 061			3-hour pressure change	Pa, scale –1
	0 10 063			Characteristic of pressure tendency	Code table
0 10 062		*		*24-hour pressure change* $p_{24}p_{24}p_{24}$	*Pa, –1*
0 07 004				Pressure (standard level)	Pa, scale –1
0 10 009				Geopotential height of the standard level	gpm
3 02 072				**Temperature and humidity data**	
	0 07 032			Height of sensor above local ground	m, scale 2
	0 07 033		*	*Height of sensor above water surface*	*m, scale 1*
	0 12 101			Temperature/dry-bulb temperature (scale 2)	K, scale 2
	0 12 103			Dew-point temperature (scale 2)	K, scale 2

	0 13 003			Relative humidity	%
1 01 005			*	Replicate one descriptor five times	
3 07 063	0 07 061		*	Depth below land surface	m, scale 2
	0 12 130		*	Soil temperature (scale 2)	K, scale 2
3 02 069				**Visibility data**	
	0 07 032			Height of sensor above local ground	m, scale 2
	0 07 033		*	Height of sensor above water surface	m, scale 1
	0 33 041		*	Attribute of following value	Code table
	0 20 001			Horizontal visibility	m, scale –1
0 07 032				Height of sensor above local ground (set to missing to cancel the previous value)	m, scale 2
0 07 033			*	Height of sensor above water surface (set to missing to cancel the previous value)	m, scale 1
0 20 031			*	Ice deposit (thickness)	m, scale 2
0 20 032			*	Rate of ice accretion	Code table
0 02 038			*	Method of sea surface temperature measurement	Code table
0 22 043			*	Sea/water temperature (scale 2)	K, scale 2
3 02 021	0 22 001		*	Direction of waves	Degree true
	0 22 011		*	Period of waves	s
	0 22 021		*	Height of waves	m, scale 1
3 02 078				**State of ground and snow depth measurement**	
	0 02 176		*	Method of state of ground measurement	Code table
	0 20 062			State of ground (with or without snow)	Code table
	0 02 177		*	Method of snow depth measurement	Code table
	0 13 013			Total snow depth	m, scale 2
0 12 113		*		Ground minimum temperature (scale2), past 12 hours **$s_nT_gT_g$**	K, 2
				Cloud data	
	0 20 010			Cloud cover (total)	%
Useful	0 08 002	*		Vertical significance	Code table, 0
considering	0 20 011	*		Cloud amount (of low or middle clouds) **N_h**	Code table, 0
the	0 20 013	*		Height of base of cloud **h**	m, –1
following	0 20 012	*		Cloud type (low clouds C_L) **C_L**	Code table, 0
Cloud	0 20 012	*		Cloud type (middle clouds C_M) **C_M**	Code table, 0
layers ?	0 20 012	*		Cloud type (high clouds C_H) **C_H**	Code table, 0
	1 05 004		*	Replicate 5 descriptors four times	
	0 08 002			Vertical significance	Code table
	0 20 011			Cloud amount	Code table
	0 20 012			Cloud type	Code table
	0 33 041		*	Attribute of following value	Code table
	0 20 013			Height of base of cloud	m, scale -1
		*		***Clouds with bases below station level***	
3 02 036	1 05 000	*		Delayed replication of 5 descriptors	
	0 31 001	*		Delayed descriptor replication factor	Numeric, 0
	0 08 002	*		Vertical significance	Code table, 0
	0 20 011	*		Cloud amount **N’**	Code table, 0
	0 20 012	*		Cloud type **C’**	Code table, 0
	0 20 014	*		Height of top of cloud **’H’**	m, scale -1
	0 20 017	*		Cloud top description **C_t**	Code table, 0
		*		***Direction of cloud drift*** **$6D_LD_MD_H$**	

3 02 047	*1 02 003*	*		*Replicate 2 descriptors 3 times*	
	0 08 002	*		*Vertical significance 7 = low cloud, 8 = middle cloud, 9 = high cloud*	*Code table, 0*
	0 20 054	*		*True direction from which clouds are moving* ***D_L, D_M, D_H***	*Degree true, 0*
0 08 002		*		*Vertical significance (set to missing to cancel the previous value)*	*Code table, 0*
		*		***Direction and elevation of cloud gr. 57CD$_a$e$_C$***	
3 02 048	*0 05 021*	*		*Bearing or azimuth D_a*	*Degree true, 2*
	0 07 021	*		*Elevation angle e_C*	*Degree, 2*
	0 20 012	*		*Cloud type C*	*Code table, 0*
	0 05 021	*		*Bearing or azimuth (set to missing to cancel the previous value)*	*Degree true, 2*
	0 07 021	*		*Elevation angle (set to missing to cancel the previous value)*	*Degree, 2*
3 02 074				***Present and past weather***	
	0 20 003			*Present weather(3)*	*Code table*
	0 04 025			*Time period (= - 60 minutes)*	*Minute*
	0 20 004			*Past weather (1) (3)*	*Code table*
	0 20 005			*Past weather (2) (3)*	*Code table*
3 02 075			*	***Intensity of precipitation, size of precipitation element***	
	0 08 021		*	*Time significance (= 2 (time averaged))*	*Code table*
	0 04 025		*	*Time period (= - 10 minutes)*	*Minute*
	0 13 055		*	*Intensity of precipitation*	*$kgm^{-2}s^{-1}$,scale 4*
	0 13 058		*	*Size of precipitation element*	*m, scale 4*
	0 08 021		*	*Time significance (= missing value)*	*Code table*
0 04 025			*	*Time period (= - 10 minutes)*	*Minute*
3 02 076			*	***Precipitation, obscuration and other phenomena***	
	0 20 021		*	*Type of precipitation*	*Flag table*
	0 20 022		*	*Character of precipitation*	*Code table*
	0 26 020		*	*Duration of precipitation (4)*	*Minute*
	0 20 023		*	*Other weather phenomena*	*Flag table*
	0 20 024		*	*Intensity of phenomena*	*Code table*
	0 20 025		*	*Obscuration*	*Flag table*
	0 20 026		*	*Character of obscuration*	*Code table*
				Wind data	
	0 07 032			*Height of sensor above local ground*	*m, scale 2*
	0 07 033			*Height of sensor above water surface*	*m, scale 1*
	0 08 021			*Time significance (= 2 (time averaged))*	*Code table*
	0 04 025			*Time period (= - 10 minutes, or number of minutes after a significant change of wind, if any)*	*Minute*
	0 11 001			*Wind direction*	*Degree true*
	0 11 002			*Wind speed*	*$m\ s^{-1}$*
	0 08 021			*Time significance (= missing value)*	*Code table*
	1 03 003			*Replicate next 3 descriptors 3 times*	
	0 04 025	*		*Time period (= - 10 minutes in the first replication, = - 60 minutes in the second replication = - 60*3 or 60*6 minutes in the third*	*Minute*

				replication)	
	0 11 043			Maximum wind gust direction	Degree true
	0 11 041			Maximum wind gust speed	$m\ s^{-1}$
	0 04 025		*	Time period (= - 10 minutes)	Minute

	0 11 016		*	Extreme counterclockwise wind direction of a variable wind	Degree true
	0 11 017		*	Extreme clockwise wind direction of a variable wind	Degree true
3 02 077				**Extreme temperature data**	
	0 07 032			Height of sensor above local ground	m, scale 2
	0 07 033		*	Height of sensor above water surface	m, scale 1
	1 04 002			Replicate 4 descriptors 2 times	
	0 04 024	*		Time period or displacement (= - 1 hour in the first replication, = - 12 or - 24 or – x hours in the second replication)	Hour, 0
	0 04 024	*		Time period or displacement (see Notes 1 and 2)	Hour, 0
	0 12 111			Maximum temperature (scale 2) at height and over period specified	K, scale 2
	0 12 112			Minimum temperature (scale 2) at height and over period specified	K, scale 2
	0 07 032		*	Height of sensor above local ground (for ground temperature)	m, scale 2
	0 04 025		*	Time period (= - 60 minutes)	Minute
	0 12 112		*	Minimum temperature (scale 2) at height and over period specified (for ground temperature)	K, scale 2
0 07 033			*	Height of sensor above water surface (set to missing to cancel the previous value)	m, scale 1
				Precipitation measurement	
	0 07 032			Height of sensor above local ground	m, scale 2
	0 02 175		*	Method of precipitation measurement	Code table
	0 02 178		*	Method of liquid water content measurement of precipitation	Code table
	1 02 005			Replicate 2 descriptors 5 times	
	0 04 024			Time period in hours t_R (= - 1 hour in the first replication, = - 3, -6, -12, - 24 hours in the next replications)	Hour, 0
	0 13 011			Total precipitation / total water equivalent of snow	$kg\ m^{-2}$, scale 1
0 07 032				Height of sensor above local ground (set to missing to cancel the previous value)	m, scale 2
				Evaporation measurement	
	0 02 185		*	Method of evaporation measurement	Code table
	1 02 002			Replicate 2 descriptors 2 times	
	0 04 024	*		Time period in hours (= -1 hour in the first replication, = -x hours in the second replication)	Hour, 0
	0 13 033			Evaporation /evapotranspiration	$kg\ m^{-2}$
3 02 081				**Total sunshine data**	

	1 02 002	*		*Replicate 2 descriptors 2 times*	
3 02 039	*0 04 024*	*		*Time period in hours* *(= -1 hour in the first replication,* *= -x hours in the second replication)*	*Hour, 0*
	0 14 031			Total sunshine	Minute
				Radiation data	
	1 07 003	*		*Replicate 7 descriptors 3 times*	
3 02 045	*0 04 024*	*		*Time period in hours* *(= -1 hour in the first replication,* *= -x hours in the next replications)*	Hour, 0
	0 14 002			*Long-wave radiation, integrated over period specified*	J m-2, scale -3
	0 14 004			*Short-wave radiation, integrated over period specified*	J m-2, scale -3
	0 14 016			*Net radiation, integrated over period specified*	J m-2, scale -4
	0 14 028			*Global solar radiation (high accuracy), integrated over period specified*	J m-2, scale -4
	0 14 029			*Diffuse solar radiation (high accuracy), integrated over period specified*	J m-2, scale -4
	0 14 030			*Direct solar radiation (high accuracy), integrated over period specified*	J m-2, scale -4
0 04 025			*	*Time period (= - 10 minutes)*	Minute
0 13 059			*	*Number of flashes*	Numeric
3 02 046		*		***Temperature change group*** $54g_0s_nd_T$	
	0 04 024	*		*Time period or displacement*	Hour, 0
	0 04 024	*		*Time period or displacement (see Note 5)*	Hour, 0
	0 12 049	*		*Temperature change over period specified* s_nd_T	K, 0
3 02 083			*	*First order statistics of P, W, T, U data*	
	0 04 025		*	*Time period (= -10 minutes)*	Minute
	0 08 023		*	*First order statistics* *(= 9 (best estimate of standard deviation))* *(6)*	Code table
	0 10 004		*	*Pressure*	Pa, scale –1
	0 11 001		*	*Wind direction*	Degree true
	0 11 002		*	*Wind speed*	m s-1
	0 12 101		*	*Temperature/dry-bulb temperature (scale 2)*	K, scale 2
	0 13 003		*	*Relative humidity*	%
	0 08 023		*	*First order statistics (= missing value)*	Code table
0 33 005			*	*Quality information (AWS data)*	Flag table
0 33 006			*	*Internal measurement status information (AWS)*	Code table

Notes: The time identification refers to the end of the one-hour period.

For SYNOP:

1) Within RA-IV, the maximum temperature at 1200 UTC is reported for the previous calendar day (i.e. the ending time of the period is not equal to the nominal time of the report). To construct the required time range, descriptor 004024 has to be included two times. If the period ends at the nominal time of the report, value of the second 004024 shall be set to 0.

2) Within RA-III, the maximum day-time temperature and the minimum night-time temperature is reported (i.e. the ending time of the period may not be equal to the nominal time of

the report). To construct the required time range, descriptor 004024 has to be included two times. If the period ends at the nominal time of the report, value of the second 004024 shall be set to 0.

3) Present weather may be represented only by 0 20 003, especially if reported from a manned non-automated station. When encoding present weather reported from an automatic weather station, the sequence of descriptors (proposed under 3 02 076) should be used, when applicable.

4) Duration of precipitation represents number of minutes in which precipitation was registered.

5) To construct the required time range, descriptor 004024 has to be included two times.

6) Best estimate of standard deviation is counted out of a set of samples (signal measurements) recorded within the period specified; it should be reported as a missing value, if the measurements of the relevant element are not available from a part of the period specified by 0 04 025.

Suggestion of the author, M. Leroy, Meteo France: Some of the parameters are very specific to some locations with cloud bases below station level, ice deposit, sea/water temperature, waves, and temperature changes. To accommodate these parameters they could be placed at the end of the template. Additional descriptors could also be added to address specific regional needs, but caution should be used in determining the amount of information which could be included in such a template. One should ask, have all possible descriptors been included or should the message be limited to only those descriptors relevant to the station?

ANNEX TO PARAGRAPH 4.1.1

FM 15 XIII METAR **Aerodrome routine meteorological report (with or without trend forecast)**

FM 16 XIII SPECI **Aerodrome special meteorological report (with or without trend forecast)**

CODE FORM:

{**METAR** or **SPECI**} **COR** CCCC YYGGgg**Z** **NIL** **AUTO** dddff**G**f_mf_m {**KMH** or **KT** or **MPS**} $d_nd_nd_n$**V**$d_xd_xd_x$

{VVVV or VVVV**NDV** or **CAVOK**} $V_NV_NV_NV_ND_v$ {**R**D_RD_R/$V_RV_RV_RV_R$i or **R**D_RD_R/$V_RV_RV_RV_R$**V**$V_RV_RV_RV_R$i} w'w' {$N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC** or **NCD**}

T'T /T'$_d$T $_d$ **Q**$P_HP_HP_HP_H$ **RE**w'w' {**WS RWY**D_RD_R or **WS ALL RWY**} (**W**T_ST_S/**S**S') (**R**$D_RD_RE_RC_Re$ $_Re_RB_RB_R$)

{(TTTTT or **NOSIG**)} TTGGgg dddff**G**f_mf_m {**KMH** or **KT** or **MPS**} {VVVV or **CAV OK**} {w'w' or **NSW**} {$N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC**}

(RMK ……………..)

Changes to FM 15 and FM 16 Regulations:

15.6 **Groups** VVVV VVVV**NDV** $V_NV_NV_NV_ND_v$

N O T E: The coding of visibility is based on the use of the metre and kilometre, in accordance with the units specified in ICAO Annex 5.

15.6.2 Directional variation in visibility $V_NV_NV_NV_ND_v$

When the horizontal visibility is not the same in different directions and when the minimum visibility is different from the prevailing visibility; and less than 1 500 metres or less than 50% of the prevailing visibility and less than 5 000 metres, the group $V_NV_NV_NV_ND_v$ shall also be used to report the minimum visibility and its general direction in relation to the aerodrome indicated by reference to one of the eight points of the compass. If the minimum visibility is observed in more than one direction, the D_v shall represent the most operationally significant direction.

15.7 **Groups** $RD_RD_R/V_RV_RV_RV_Ri$ or $RD_RD_R/V_RV_RV_RV_R$**V**$V_RV_RV_RV_Ri$

N 0 T E: The coding of runway visual range is based on the use of the metre in accordance with the unit specified in ICAO Annex 5.

15.7.3 **Runway designator** D_RD_R/

The designator of each runway for which runway visual range is reported shall be indicated by D_RD_R. Parallel runways should be distinguished by appending to D_RD_R letters L, C or R indicating the left, central or right parallel runway, respectively. The letter(s) shall be appended to D_RD_R as necessary in accordance with the standard practice for runway designation, as laid down by ICAO in Annex 14 - Aerodromes, Volume I - Aerodrome design and operations, paragraphs 5.2.2.4 and 5.2.2.5.

15.8.6 If more than one significant weather phenomenon is observed, separate w'w' groups shall be included in the report in accordance with Code table 4678. However, if more than one form of precipitation is observed, the appropriate letter abbreviations shall be combined in a single group with the dominant type of precipitation being reported first. In such a single group, the intensity shall refer to the total precipitation and be reported with one or no indicator as appropriate.

When an automatic observing system is used and when the type of the precipitation cannot be identified by this system, the abbreviation UP shall be used for precipitation. The abbreviation UP may be combined, as necessary, with the following characteristics of present weather: FZ, SH and TS.

15.8.10 The qualifier VC shall be used to indicate the following significant weather phenomena observed in the vicinity of the aerodrome: TS, DS, SS, FG, FC, SH, PO, BLDU, BLSA, BLSN and VA. Regulations referring to the combination of VC and FG are given in Regulation 15.8.17.

NOTES:

(1) Such weather phenomena should be reported with the qualifier VC only when observed between approximately 8 km and 16 km from the aerodrome reference point.

(2) See Regulation 15.8.7.

$N_S N_S N_s h_s h_s h_s$

or

15.9 **Group $VVh_s h_s h_s$**

or **NSC**

or NCD

15.9.1 *Cloud amount and cloud height* $N_S N_S N_s h_s h_s h_s$

15.9.1.1 Cloud amount, cloud type and height of cloud base shall be reported to describe the clouds of operational significance, i.e. clouds with the height of base below 1500 meters (5000 ft) or below the highest minimum sector altitude, whichever is greater, or Cumulonimbus or towering Cumulus at any height. The cloud amount $N_S N_S N_s$ shall be reported as few (1 to 2 oktas), scattered (3 to 4 oktas), broken (5 to 7 oktas) or overcast (8 oktas), using the three-letter abbreviations FEW, SCT, BKN and OVC followed, without a space, by the height of the base of the cloud layer (mass) hshshs. If there are no clouds below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater, no Cumulonimbus and no towering cumulus and no restriction on vertical visibility and the abbreviation CAVOK is not appropriate, then the abbreviation NSC shall be used. When an automatic observing system is used and no clouds are detected by that system, the abbreviation NCD shall be used.

15.9.1.6 When cumulonimbus clouds or towering cumulus clouds are detected by the automatic observing system and the cloud amount and the height of cloud base cannot be observed, the cloud amount and the height of cloud base should be replaced by "//////"

15.10 **Code word CAVOK**

The code word **CAVOK** shall be included in place of the groups under Regulations 15.6, 15.8 and 15.9, when the following conditions occur simultaneously at the time of observation:

(a) Visibility: 10 km or more;
(b) No cloud below 1 500 metres (5 000 ft) or below the highest minimum sector altitude, whichever is greater, and no Cumulonimbus and no towering cumulus;
(c) No significant weather phenomena (see Code table 4678).

N O T E: Highest minimum sector altitude is defined in ICAO PANS-OPS, Part 1 - Definitions, as the lowest altitude which may be used under emergency conditions which will provide a minimum clearance of 300 metres (1 000 ft) above all objects located in an area contained within a sector of a circle of 46 km (25 nautical miles) radius centred on a radio aid to navigation.

15.12.2 If the value of QNH is less than 1000 hPa, it shall be preceded by 0; for example, QNH 995.6 shall be reported as Q0995.
NOTES:
(1) When the first digit following the letter indicator Q is either 0 or 1, the QNH value is reported in the unit hectopascal (hPa).
(2) The unit prescribed by ICAO Annex 5 for pressure is the hectopascal.

15.13 **Supplementary information – groups**

	WS RD_RD_R		
REw'w'	or		(**W**T_ST_S/**SS**') (**R**$D_RD_RE_RC_Re_Re_RB_RB_R$)
	WS ALL RWY		

…

15.13.3 **Wind shear in the lower layers** or **WS R**D_RD_R / **WS ALL RWY**

15.13.6 State of the runway (**R**$D_RD_RE_RC_Re_Re_RB_RB_R$)

15.13.6.1 Subject to regional air navigation agreement, information on the state of the runway provided by the appropriate airport authority shall be included. The runway deposits E_R, the extent of runway contamination C_R, the depth of deposit e_Re_R and the friction coefficient/braking action BRBR shall be indicated in accordance with code tables 0919, 0519, 1079 and 0366, respectively. The state of the runway group shall be replaced by the abbreviation SNOCLO when the aerodrome is closed due to extreme deposit of snow. If contaminations on a single runway or on all runways at an aerodrome have ceased to exist, this should be reported by replacing the last six digits of the group by "CLRD//".

Note.- Concerning runway designator D_RD_R, Regulation 15.7.3 applies. Additional code figures 88 and 99 are reported in accordance with the European Air Navigation Plan, FASID, Part III-AOP, Attachment A.

15.13.2.1 Up to three groups of information on recent weather shall be given by the indicator letters RE followed, without a space, by the appropriate abbreviations, in accordance with Regulation 15.8 (but no intensity of the recent weather phenomena shall be indicated) if the following weather phenomena were observed during the period since the last routine report, or last hour, whichever is shorter, but not at the time of observation:

- Freezing precipitation;
- Moderate or heavy drizzle, rain or snow;
- Moderate or heavy: ice pellets, hail, small hail and/or snow pellets;
- Blowing snow;
- Sandstorm or duststorm;
- Thunderstorm;
- Funnel cloud(s) (tornado or water-spout);
- Volcanic ash.

When an automatic observing system is used and when the type of the precipitation cannot be identified by this system, the abbreviation REUP shall be used for recent precipitation. It may be combined with the characteristics of the present weather in accordance with Regulation 15.8.6.

15.14.12 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate the onset, cessation or change in intensity of the following weather phenomena:

- Freezing precipitation;

- Moderate or heavy precipitation (including showers);

- Duststorm;
- Sandstorm;
- Thunderstorm (with precipitation)

15.14.13 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate the onset or cessation of the following weather phenomena:

- Freezing fog;
- Ice crystals;
- Low drifting dust, sand or snow;
- Blowing dust, sand or snow;
- Thunderstorm without precipitation;
- Squall
- Funnel cloud (tornado or waterspout

15.14.14 To indicate the end of significant weather phenomena w'w', the abbreviation NSW (Nil Significant Weather) shall replace the group w'w'.

15.14.15 When no cloud below 1 500 metres (5 000 ft) or the highest minimum sector altitude, whichever is greater, and no Cumulonimbus and no towering cumulus are forecast, and **CAVOK is** not appropriate, the abbreviation NSC shall be used.

.....

FM 51 XIII TAF **Aerodrome forecast**

CODE FORM:

{ **TAF AMD** or / **TAF COR** or / **TAF** } CCCC YYGGgg**Z** { **NIL** or $Y_1Y_1G_1G_1$/$Y_2Y_2G_2G_2$ } { dddff**G**f_mf_m or **CNL** } { **KMH** or **KT** or **MPS** }

{ VVVV w'w' or **CAVOK** } { $N_SN_SN_Sh_sh_sh_s$ or VV$\mathbf{h_sh_sh_s}$ or **NSC** }

(**TX**T_FT_F/$Y_FY_FG_FG_F$**Z** **TN**T_FT_F/$Y_FY_FG_FG_F$**Z**)

{ { **PROB** C_2C_2 or / **PROB** C_2C_2 TTTTT / or TTTTT } YYGG/$Y_eY_eG_eG_e$ or TTYYGGgg } dddff**G**f_mf_m { **KMH** or **KT** or **MPS** } { VVVV { w'w' or **NSW** } { $N_SN_SN_Sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC** } or **CAVOK** }

CHANGES to REGULATIONS:

51.1.4 The forecast shall cover the period $Y_1Y_1G_1G_1$ to $Y_2Y_2G_2G_2$. The forecast period may be divided into two or more self-contained parts by the use of the time indicator group TTYYGGgg in the form of FMYYGGgg. A complete description of the forecast prevailing conditions shall be given at the beginning of the forecast or the self-contained parts designated by FMYYGGgg. If any element is expected to change significantly during the forecast period or a selfcontained part thereof, one or more sets of change groups TTTTT YYGG/$Y_eY_eG_eG_e$ shall be added after the complete description of the conditions prevailing before the change. Each change group shall be followed by the modified elements subject to Regulation 51.1.5.

NOTES:
(1) The governing criteria for inclusion of change groups are specified in publication WMO-No. 49 -Technical Regulations [C.3.1].
(2) See Regulation **51.8.1.**

51.1.5 The group w'w' and/or the group $N_SN_SN_Sh_Sh_Sh_S$, or **VV**$h_Sh_Sh_S$ shall be omitted if the corresponding element(s) is (are) expected to be absent or not significant. After change groups TTTTT YYGG/$Y_eY_eG_eG_e$, elements shall be omitted if they are not expected to differ significantly from the preceding values they possessed in the coded forecast (see Regulations 51.5.2, 51.6.1.7 and 51.6.3). However, in case of significant change of the clouds, all cloud groups, including any significant layer(s) or masses not expected to change, shall be given.

…

51.4 **Group VVVV**

NOTE: The coding of visibility is based on the use of the metre and kilometre, in accordance with the units specified in ICAO Annex *5.*

…

51.5.1 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate the occurrence, cessation or change in intensity of the following weather phenomena:
- Freezing precipitation;

- Moderate or heavy precipitation (including showers);

- Duststorm;
- Sandstorm;
- Thunderstorm (with precipitation);

51.5.2 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate the occurrence or cessation of the following weather phenomena:

- Ice crystals;
- Freezing fog;
- Low drifting dust, sand or snow;
- Blowing dust, sand or snow;
- Thunderstorm without precipitation;
- Squall;
- Funnel cloud (tornado or water spout)

…

$N_SN_SN_Sh_Sh_Sh_S$

or

51.6 **Group VV**$h_Sh_Sh_S$

or NSC

…

TTTTT YYGG/ $Y_eY_eG_eG_e$

51.8 **Groups** or

TTYYGGgg

51.8.1 These groups shall be used when, during the period $Y_1Y_1G_1G_1$ to $Y_2Y_2G_2G_2$, a change in some or all of the elements forecast is expected to occur at some intermediate time YYGGgg or during the period YYGG to $Y_eY_eG_eG_e$. Such groups shall not be introduced until all the data groups necessary to describe the elements forecast in the period $Y_1Y_1G_1G_1$ to Y_2Y_2 G_2G_2 or YYGGgg have been given.

NOTES:
(1) If the end of the forecast period is midnight, Y_eY_e should be the date before midnight and G_eG_e should be indicated as 24.
(2) See Note (1) to Regulation 51.1.4.

51.8.2 The time indicator group TTYYGGgg in the form of FMYYGGgg (from YYGGgg) shall be used to indicate the beginning of a self-contained part of the forecast indicated by YYGGgg. When the group FMYYGGgg is used, all forecast conditions given before the group FMYYGGgg are superseded by the conditions indicated after the group.

51.8.3 The change groups TTTTT YYGG/ $Y_eY_eG_eG_e$ in the form of BECMG YYGG/ $Y_eY_eG_eG_e$ shall indicate a change to forecast meteorological conditions expected to occur at either a regular or irregular rate at an unspecified time within the period YYGG to $Y_eY_eG_eG_e$. The duration of the period YYGG to $Y_eY_eG_eG_e$ shall normally not exceed two hours and in any case shall not exceed four hours. The change groups shall be followed by a description of all the elements for which a change is forecast. When an element is not described in data groups which follow the change groups, the description of this element for the period between $Y_1Y_1G_1G_1$ and Y_2Y_2 G_2G_2 shall be considered to remain valid subject to Regulation 51.1.5.

N O T E : The conditions described after the groups BECMG YYGG/ $Y_eY_eG_eG_e$ are those expected to prevail from $Y_eY_eG_eG_e$ until Y_2Y_2 G_2G_2, unless a further change is expected, in which case a further set of change groups BECMG YYGG/ $Y_eY_eG_eG_e$ or FMYYGGgg must be used.

51.8.4 The change groups TTTTT YYGG/ $Y_eY_eG_eG_e$ in the form of TEMPO YYGG/ $Y_eY_eG_eG_e$ shall indicate frequent or infrequent temporary fluctuations to forecast meteorological conditions which are expected to last less than one hour in each instance and, in the aggregate cover, less than half of the period indicated by YYGG/ $Y_eY_eG_eG_e$.

NOTES:
(1) If the modified forecast condition is expected to last one hour or more, Regulation 51.8.2 or 51.8.3 applies, i.e. the change groups BECMG YYGG/ $Y_eY_eG_eG_e$ or FMYYGGgg must be used at the beginning and end of the period during which conditions are expected to depart from those forecast prior to YYGG or YYGGgg.
(2) To keep forecasts clear and unambiguous, the use of change indicators should be carefully considered and kept to a minimum. In particular, the overlapping of change periods should be avoided. At any time during the period of validity of the TAF, only one possible variation to the prevailing forecast conditions should normally be indicated. The subdivision of the forecast period by FMYYGGgg should be used to avoid too complex forecasts in cases where many significant changes to weather conditions are expected to occur throughout the forecast period.

51.9 **Groups PROB**C_2C_2 YYGG/ $Y_eY_eG_eG_e$

51.9.1 In order to indicate the probability of occurrence of alternative value(s) of forecast element(s), during a defined period of time, the **PROB**C_2C_2 YYGG/ $Y_eY_eG_eG_e$ shall be placed directly before the alternative value(s). For C_2C_2, only the values 30 and 40 shall be used to indicate the probabilities 30 and 40%, respectively.

N O T E: A probability of less than 30% of actual values deviating from those forecast is not considered to justify the use of the group PROB. When the possibility of an alternative value is 50% or more, this should be indicated by the use of BECMG, TEMPO or FM as appropriate.

51.9.2 A probability statement may also be related to the occurrence of temporary fluctuations. In this case, the group **PROB**C_2C_2 shall be placed immediately before the change group TEMPO and the group YYGG/ $Y_eY_eG_eG_e$ shall be placed after TEMPO (for example PROB30 TEMPO 2922/3001).

51.9.3 The group **PROB**C_2C_2 shall not be used in combination with the change indicator group BECMG or the time indicator group FMYYGGgg.

51.10 **Groups (TX**T_FT_F/$Y_FY_FG_FG_F$**Z TN**T_FT_F/$Y_FY_FG_FG_F$**Z)**

51.10.1 To indicate forecast maximum and minimum temperatures expected to occur at the time indicated by $Y_FY_FG_FG_F$**Z**, the letter indicator **TX** for the maximum forecast temperature and **TN** for the minimum forecast temperature shall precede T_FT_F without a space.

CHANGES TO SPECIFICATION OF SYMBOLIC LETTERS

1. **Entry for YY**
   Delete FM51 from sub-paragraph (b)

   Add subparagraphs
   (d) On which the forecast was issued. (FM51)
   (e) Indicating the date (day) on which part of the forecast commences or a forecast change commences. (FM51)

2. **Entry for Y_FY_F**
   Add paragraph
   Valid day of month (UTC) of the temperature forecast (FM51)

3. **Entry for Y_eY_e**
   Add paragraph
   Day of month (UTC) of end of forecast change

4. **Entry for Y_2Y_2**
   Add FM51 to the list of code forms.

ANNEX TO PARAGRAPH 4.1.2

Table A6-1. Template for SIGMET and AIRMET messages and special air-reports (uplink)

Key: M = inclusion mandatory, part of every message
C = inclusion conditional, included whenever applicable
= = a double line indicates that the text following it should be placed on the subsequent line

Note.— The ranges and resolutions for the numerical elements included in SIGMET/AIRMET messages and in special air- reports are shown in Table A6-4 of this appendix.

Element as specified in Chapter 5 and Appendix 6	*Detailed content*	*Template(s)*				*Examples*
		SIGMET	~~*SIGMET SST1*~~	*AIRMET*	*SPECIAL AIR-REPORT*[21]	
Location indicator of FIR/CTA (M)[32]	ICAO location indicator of the ATS unit serving the FIR or CTA to which the SIGMET/ AIRMET refers (M)	nnnn			—	YUCC[43] YUDD[43]
Identification (M)	Message identification and sequence number[54] (M)	SIGMET [nn]n	~~SIGMET SST [nn]n~~	AIRMET [nn]n	ARS	SIGMET 5 SIGMET A3 ~~SIGMET SST 1~~ AIRMET 2 ARS
Validity period (M)	Day-time groups indicating the period of validity in UTC (M)	VALID nnnnnn/nnnnnn			—[65]	VALID 221215/221600 VALID 101520/101800 VALID 251600/252200
Location indicator of MWO (M)	Location indicator of MWO originating the message with a separating hyphen (M)	nnnn—				YUDO—[43] YUSO—[43]
Name of the FIR/ CTA *or* aircraft identification (M)	Location indicator and name of the FIR/CTA[76] for which the SIGMET/ AIRMET is issued *or*aircraft radiotelephony call sign (M)	nnnn nnnnnnnnnn FIR[/UIR] *or* nnnn nnnnnnnnnn CTA		nnnn nnnnnnnnnn FIR[/n]	nnnnnn	YUCC AMSWELL FIR[43] YUDD SHANLON FIR/UIR[43] YUCC AMSWELL FIR/2[43] YUDD SHANLON FIR[43] VA812
IF THE SIGMET IS TO BE CANCELLED, SEE DETAILS AT THE END OF THE TEMPLATE.						
Phenomenon (M)[87]	Description of phenomenon causing the issuance of SIGMET/AIRMET (C)	OBSC[98] TS [GR[109]] EMBD[1210] TS [GR] FRQ[1311] TS [GR] SQL[1412] TS [GR] TC nnnnnnnnnn SEV TURB[1113] SEV ICE[1914] SEV ICE (FZRA)[2014] SEV MTW[2115] HVY DS HVY SS VA[ERUPTION] [MT nnnnnnnnnn] [LOC	~~MOD TURB~~[11] ~~SEV TURB~~ ~~ISOL~~[15] ~~CB~~[16] ~~OCNL~~[18] ~~CB~~ ~~FRQ~~[13] ~~CB~~ ~~GR~~ ~~VA[ERUPTION]~~ ~~[MT nnnnnnnnnn]~~ ~~[LOC~~ ~~Nnn[nn] *or* Snn[nn]~~ ~~Ennn[nn] *or*~~ ~~Wnnn[nn]] VA CLD~~	SFC WSPD nn[n]KMH (*or* SFC WSPD nn[n]KT) SFC VIS nnnnM (nn)[1716] ISOL[1517] TS[GR][109] OCNL[18] TS[GR] MT OBSC BKN CLD nnn/[ABV]nnnnM (*or* BKN CLD nnn/[ABV]nnnnFT)	TS TSGR SEV TURB SEV ICE SEV MTW HVY SS VA CLD [FL nnn/nnn] VA [MT nnnnnnnnnn]	SEV TURB FRQ TS OBSC TSGR EMBD TSGR TC GLORIA VA ERUPTION MT ASHVAL LOC S15 E073 VA CLD MOD TURB MOD MTW ISOL CB BKN CLD 120/900M (BKN CLD

Element as specified in Chapter 5 and Appendix 6	*Detailed content*	*Template(s)*				*Examples*
		SIGMET	~~*SIGMET SST1*~~	*AIRMET*	*SPECIAL AIR-REPORT*[21]	
		Nnn[nn] *or* Snn[nn] Ennn[nn] *or* Wnnn[nn]] VA CLD RDOACT CLD		OVC CLD nnn/[ABV]nnnnM (*or* OVC CLD nnn/[ABV]nnnnFT) ISOL[15][17] CB[16][19] OCNL[18] CB FRQ[13][11] CB ISOL[15][17] TCU[16][19] OCNL[18] TCU[16][19] FRQ[13][11] TCU MOD TURB[11][13] MOD ICE[19][14] MOD MTW[21][15]	SMELL SU	400/3000FT) OVC CLD 270/ABV3000M (OVC CLD 900/ABV10000FT) SEV ICE SMELL SU RDOACT CLD
Observed or forecast phenomenon (M)	Indication whether the information is observed and expected to continue, *or* forecast (M)	OBS [AT nnnnZ] FCST			OBS AT nnnnZ	OBS AT 1210Z OBS FCST
Location (C)	Location (referring to latitude and longitude (in degrees and minutes) *or* locations or geographic features well known internationally)	Nnn[nn] Wnnn[nn] *or* Nnn[nn] Ennn[nn] *or* Snn[nn] Wnnn[nn] *or* Snn[nn] Ennn[nn] *or* N OF Nnn[nn] *or* *S OF Nnn[nn] or* *N OF Snn[nn] or* S OF Snn[nn] *or* [AND] W OF Wnnn[nn] *or* E OF Wnnn[nn] *or* *W OF Ennn[nn] or* E OF Ennn[nn] *or* [N OF, NE OF, E OF, SE OF, S OF, SW OF, W OF, NW OF] [LINE] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] — Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] *or* [N OF, NE OF, E OF, SE OF, S OF, SW OF, W OF, NW OF, AT] nnnnnnnnnnnn *or* WI Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] — Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] — Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] — [Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] — Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]			NnnnnWnnnnn *or* NnnnnWnnnnn or SnnnnWnnnnn or SnnnnEnnnnn	S OF N54 N OF N50 N2020 W07005 YUSB[43] N2706 W07306 N48 E010 N OF N1515 AND W OF E13530 W OF E1554 N OF LINE S2520 W11510 - S2520 W12010 WI N6030 E02550 - N6055 E02500 - N6050 E02630
Level (C)	Flight level *and* extent[22][20] (C)	FLnnn *or* FLnnn/nnn *or* TOP FLnnn *or* [TOP] ABV FLnnn *or* [TOP] BLW FLnnn *or* BLW nnnnM (*or* BLW nnnnFT) *or*[23][21] CB TOP [ABV] FLnnn WI nnnKM OF CENTRE (*or* CB TOP [ABV] FLnnn WI nnnNM OF CENTRE) or CB TOP [BLW] FLnnn WI nnnKM OF CENTRE (*or* CB TOP [BLW] FLnnn WI nnnNM OF CENTRE) *or*[24][22] FLnnn/nnn [APRX nnnKM BY nnnKM] [nnKM WID LINE[23] BTN (nnNM WID LINE BTN)] [Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]]] (*or* FLnnn/nnn [APRX nnnNM BY nnnNM] [Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]]])			FLnnn	FL180 FL050/080 TOP FL390 BLW FL200 TOP ABV FL100 FL310/450 CB TOP FL500 WI 270KM OF CENTRE (CB TOP FL500 WI 150NM OF CENTRE) FL310/350 APRX 220KM BY 35KM FL390
Movement or	Movement or	MOV N [nnKMH] *or* MOV NE [nnKMH] *or* MOV E [nnKMH] *or*			—	MOV E 40KMH

Element as specified in Chapter 5 and Appendix 6	*Detailed content*	*Template(s)*				*Examples*
		SIGMET	~~*SIGMET SST1*~~	*AIRMET*	*SPECIAL AIR-REPORT*[~~2~~1]	
expected movement (C)	expected movement (direction and speed) with reference to one of the eight points of compass, or stationary (C)	MOV SE [nnKMH] *or* MOV S [nnKMH] *or* MOV SW [nnKMH] *or* MOV W [nnKMH] *or* MOVNW[nnKMH] (*or* MOV N [nnKT] or MOV NE [nnKT] *or* MOV E [nnKT] *or* MOV SE [nnKT] *or* MOVS[nnKT] *or* MOV SW [nnKT] *or* MOV W [nnKT] *or* MOV NW [nnKT]) *or* *STNR*				(MOV E 20KT) MOV SE STNR
Changes in intensity (C)	Expected changes in intensity (C)	INTSF *or* WKN *or* NC			—	WKN
Forecast position (C)[~~22~~20]	Forecast position of volcanic ash cloud *or* the centre of the TC at the end of the validity period of the SIGMET message (C)	FCST nnnnZ TC CENTRE Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] *or* FCST nnnnZ VA CLD APRX [nnKM WID LINE[23] BTN (nnNM WID LINE BTN)] Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn]Wnnn[nn] *or* Ennn[nn]]		—	—	FCST 2200Z TC CENTRE N2740 W07345 FCST 1700Z VA CLD APRX S15 E075 – S15 E081 – S17 E083 – S18 E079 – S15 E075

OR

Cancellation of SIGMET/ AIRMET[~~26~~24](C)	Cancellation of SIGMET/AIRMET referring to its identification	CNL SIGMET [nn]n nnnnnn/nnnnnn *or* CNL SIGMET [nn]n nnnnnn/nnnnnn [VA MOV TO nnnn FIR][~~24~~22]	~~CNL SIGMET SST [nn]n nnnnnn/nnnnnn~~	CNL AIRMET [nn]n nnnnnn/nnnnnn	—	CNL SIGMET 2 101200/101600[~~26~~24] CNL SIGMET 3 251030/251430 VA MOV TO YUDO FIR[~~26~~24] ~~CNL SIGMET SST 1 212330/22013026~~ CNL AIRMET 151520/151800[~~26~~24]

Notes.—

~~1. In accordance with 1.1.2.~~
~~2~~1. No wind and temperature to be uplinked to other aircraft in flight in accordance with 3.2.
~~3~~2. See 4.1.
~~4~~3. Fictitious location.
~~5~~4. In accordance with 1.1.3 and 2.1.2.
~~6~~5. See 3.1.
~~7~~6. See 2.1.3.
~~8~~7. In accordance with 1.1.4 and 2.1.4.
~~9~~8. In accordance with 4.2.1 a).
~~10~~9. In accordance with 4.2.4.
~~12~~10 In accordance with 4.2.1 b).
~~13~~11 In accordance with 4.2.2.
~~14~~12 In accordance with 4.2.3.
~~11~~13 In accordance with 4.2.5 and 4.2.6.
~~19~~14 In accordance with 4.2.7.
~~21~~15 In accordance with 4.2.8.
~~17~~16 In accordance with 2.1.4.
~~15~~17 In accordance with 4.2.1 c).
18 In accordance with 4.2.1 d).
~~16~~19 The use of cumulonimbus, CB~~, is restricted to AIRMETs and SIGMETs related to SST flight during transonic and supersonic cruise; the use of~~and towering cumulus, TCU, is restricted to AIRMETs in accordance with~~ 1.1.4 and~~ 2.1.4.
~~20 . In accordance with 4.2.7.~~
~~22~~20 Only for SIGMET messages for volcanic ash cloud and tropical cyclones.
~~23~~21 Only for SIGMET messages for tropical cyclones.
~~24~~22 Only for SIGMET messages for volcanic ash.
~~25~~23 A straight line between two points drawn on a map in the Mercator projection or a straight line between two points which crosses lines of longitude at a constant angle.
~~26~~24 End of the message (as the SIGMET/AIRMET message is being cancelled).

ANNEX TO PARAGRAPH 4.2

For operational implementation in November 2007:

- Recommendation to CBS of changes by Expert Meeting on Codes in ICAO, Montreal 8-12 May 2006
- Endorsement of recommendation to CBS of changes by ICT on ISS in Geneva, September 2006
- Recommendation of changes by CBS, Seoul, Korea November 2006
- Final approval of CBS recommendation by EC in June 2007
- Operational implementation on 7 November 2007

For operational implementation in November 2011:

- Study of proposed changes by ET/DR&C in 2009
- Recommendation to CBS of changes by Expert Meeting on Codes in 2010
- Endorsement of recommendation to CBS of changes by ICT on ISS in 2010
- Recommendation of changes by CBS in 4th quarter 2010
- Final approval of CBS recommendation by EC in June 2011
- Implementation in November 2011

ANNEX TO PARAGRAPH 4.3

It is proposed to modify Regulation 15.9.1.1 in the Manual on Codes, WMO-No. 306, Volume I.1 in such a way that the existing text of this regulation would be preceded by the first sentence of Regulation 4.6.5.1 [1]:

15.9.1.1 Cloud amount, cloud type and height of cloud base shall be reported to describe the clouds of operational significance, i.e. clouds with the height of base below 1500 meters (5000 ft) or below the highest minimum sector altitude, whichever is greater, or Cumulonimbus or towering Cumulus at any height. The cloud amount $N_sN_sN_s$ shall be reported ......

ANNEX TO PARAGRAPH 5.2

Pre-operational

Proposal for new descriptors and a Note under the Class 13

F X Y	Element name	BUFR				CREX		
0 11 054	Mean wind direction for 1500 m – 3000 m	Degree true	0	0	9	Degree true	0	3
0 11 055	Mean wind speed for 1500 m – 3000 m	$m\ s^{-1}$	1	0	12	$m\ s^{-1}$	1	4
0 13 047	Modified Showalter stability index	K	0	-60	6	ºC	0	2

It is proposed to add a Note under Class 13:

The "Modified Showalter stability index" is defined as the temperature difference between the ambient 500 hPa temperature and the temperature a parcel of air, initially at a selected base level, would have if brought from its condensation level to the 500 hPa surface by a moist adiabatic process. Positive values denote stable conditions, while negative values denote unstable conditions. The base level is 850 hPa, 800hPa or 750 hPa if the station elevation is less than 1000, 1000 to 1400 or 1401 to 2000 gpm above mean sea level, respectively.

Coverage of regional coding procedures in BUFR template for TEMP and TEMP SHIP data

If reporting of P,T,U or wind data at additional levels is required by Regional coding procedures for TEMP and TEMP SHIP data, the current BUFR template for TEMP, TEMP SHIP and TEMP MOBIL data can be used without any modification.

Regional coding procedures in RA IV

The RA IV Regional coding procedures, however, require data representation of additional information that is specified in Manual on Codes, WMO-No. 306, Volume II, by supplementary groups $101A_{df}A_{df}$ (code table 421 for $A_{df}A_{df}$ – Form of additional data reported).

RA IV BUFR template for TEMP and TEMP SHIP data:

Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data on global scale is defined by **3 09 052.** It is proposed to add the following entries to allow representation of data in the groups $101A_{df}A_{df}$.

3 09 052		**Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data**	
		may be supplemented by:	
		Reason for no report or incomplete report	
0 35 035		Reason for termination	Code table
		Corrected data	
1 04 000		Delayed replication of 4 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric
2 04 001		Add associated field of 1 bit in length	
0 31 021		Associated field significance = 21 (indicator of correction)	Code table
		Associated field set to 1 (corrected value)	
3 03 054		Temperature, dew-point, wind at a pressure level with radiosonde position	

2 04 000		Cancel Add associated field	
0 08 042		Extended vertical sounding significance = missing (to cancel the previous value)	Flag table
		Stability index and mean wind data	
0 13 047		Modify Showalter stability index	K
0 11 044		Mean wind direction for surface – 1500 m	Degree true
0 11 045		Mean wind speed for surface – 1500 m	$m\ s^{-1}$, scale 1
0 11 054		Mean wind direction for 1500 m – 3000 m	Degree true
0 11 055		Mean wind speed for 1500 m – 3000 m	$m\ s^{-1}$, scale 1
		Doubtful data	
1 12 000		Delayed replication of 12 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric
1 11 002		Replicate next 11 descriptors 2 times	
0 04 086		Long time period or displacement (since launch time)	Second
0 08 040		Flight level significance In the 1st replication = 4 (Begin doubtful temperature, height data), in the 2nd replication = 9 (End doubtful temperature, height data).	Code table
0 07 004		Pressure	Pa, scale –1
0 05 015		Latitude displacement since launch site (high accuracy)	Degree, scale 5
0 06 015		Longitude displacement since launch site (high accuracy)	Degree, scale 5
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric
0 10 009		Geopotential height	gpm
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric
0 12 101		Temperature/dry-bulb temperature (scale 2)	K, scale 2
		Extrapolated geopotential data	
1 08 000		Delayed replication of 8 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric
0 04 086		Long time period or displacement (since launch time)	Second
0 08 040		Flight level significance = 31 (Incremented height level (generated))	Code table
0 07 004		Pressure	Pa, scale –1
0 05 015		Latitude displacement since launch site (high accuracy)	Degree, scale 5
0 06 015		Longitude displacement since launch site (high accuracy)	Degree, scale 5
0 10 009		Geopotential height	gpm
0 11 001		Wind direction	Degree true
0 11 002		Wind speed	$m\ s^{-1}$, scale 1

ANNEX TO PARAGRAPH 5.4.2

Pre-operational

TM 309054 - BUFR template for reports of monthly aerological means suitable for CLIMAT TEMP and CLIMAT TEMP SHIP data

3 09 054		**Sequence for representation CLIMAT TEMP and CLIMAT TEMP SHIP data**

Sequence BUFR descriptor <3 09 054> expands as it is shown in the leftmost column below:

		Identification of launch site	Unit, scale
3 01 001	0 01 001	WMO block number	Numeric, 0
	0 01 002	WMO station number	Numeric, 0
0 01 011		Ship's call sign	CCITT IA5, 0
		Date/time(1)	
3 01 011	0 04 001	Year(1)	Year, 0
	0 04 002	Month(1)	Month, 0
	0 04 003	Day (= 1) (1)	Day, 0
3 01 012	0 04 004	Hour (= 0) (1)	Hour, 0
	0 04 005	Minute (= 0) (1)	Minute, 0
		Horizontal and vertical coordinates	
3 01 021	0 05 001	Latitude (high accuracy)	Degree, 5
	0 06 001	Longitude (high accuracy)	Degree, 5
0 07 030		Height of station ground above mean sea level	m, 1
0 07 031		Height of barometer above mean sea level	m, 1
0 07 007		Height release of sonde above mean sea level	m, 0
		Monthly mean data	
0 04 023		Time period (= number of days in the month)	Day, 0
0 04 059		Times of observations used to compute the reported mean values	Flag table, 0
1 15 000		Delayed replication of 15 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric, 0
0 08 001		Vertical sounding significance	Flag table, 0
0 08 023		First order statistics (= 4; mean value)	Code table, 0
0 07 004		Pressure	Pa, –1
0 10 009		Geopotential height	gpm, 0
0 12 101		Temperature/dry-bulb temperature	K, 2
0 12 103		Dew-point temperature	K, 2
0 08 023		First order statistics (= 32; vector mean)	Code table, 0
0 11 001		Wind direction	Degree true, 0
0 11 002		Wind speed	$m\ s^{-1}$, 1
0 08 023		First order statistics (= 63; missing value)	Code table, 0
0 11 019		Steadiness of wind	%, 0
0 08 050		Qualifier for number of missing values in calculation of statistic (= 2; temperature)	Code table, 0
0 08 020		Total number of missing entities (days)	Numeric, 0
0 08 050		Qualifier for number of missing values in calculation of statistic (= 9; wind)	Code table, 0
0 08 020		Total number of missing entities (days)	Numeric, 0

Note:

(1) The time identification refers to the beginning of the one-month period.

ANNEX TO PARAGRAPH 5.4.3

For validation

Sequence number required for all existing BUOY template 3 08 005

PROPOSED BUFR TEMPLATE FOR BUOY AND WAVE DATA

Proposed template is listed in the table 1 below. Descriptors number 1 to 84 in the table correspond to the existing BUFR template for buoy data.

Descriptors used are from BUFR Master table 0, version 11. No local table is being used.

- Are indicated in red descriptors that are presently being used for BUFR encoding of PDE buoy data
- Are indicated in blue descriptors that are similar to those being used for BUFR encoding of PDE buoy data (i.e. another way to code the same information is proposed)
- Are indicated in green, information which will have to be encoded for PDE buoys if the information is available (i.e. will be useful or required by users)
- ***New proposed descriptors for BUFR template for buoy data are indicated in bold and italic. They correspond to descriptors 85 and after.***

Implication for PDE (Puertos Del Estado, Spain) buoys:

- Buoy WMO identification number to be coded and divided in 3 descriptors instead of 1 (i.e. 001003, 001020, and 001005).
- Buoy position to be coded in high accuracy instead of coarse accuracy.
- Air pressure reduced to sea level (MSLP) must be computed and encoded.
- Sensor height with regard to platform deck and average sea level will have to be encoded for air temperature and wind; wind is assumed to be corrected to 10m so this will have to be indicated in the reports (i.e. 008082 coded 1, and 007033 coded for 10m).
- Fields for which information is not available will be coded with “missing”.
- Section 1 of existing PDE BUFR reports was not encoded according to existing regulations:
    - Local table version should be coded 0 (not 1) as all descriptors being used are formal WMO descriptors (i.e. no PDE local descriptors are being used).
    - Current B§UFR table version is 11 (not 1)
    - Year should be coded as following: YYYY coded (YYYY-100*(Century-1)), e.g. 2005 coded 05.

Proposed new template for buoy data, including directional and non-directional wave data

#	Descriptor	Name	Expanded descriptors	Comment, encoding
1	001003	WMO region	001003	First digit of WMO number (e.g. 62024 => 6)
2	001020	WMO region sub-area	001020	Second digit of WMO number (e.g. 62024 => 2)
3	001005	Buoy/platform identifier	001005	Last 3 digits of WMO number (e.g. 62024 => 024)
4	002001	Type of station	002001	1=Manned station
5	002036	Buoy type	002036	1=Fixed buoy
6	002149	Type of data buoy	002149	16=unspecified moored buoy 24=Omnidirectional waverider 25=Directional waverider
7	301011	Date	004001 (year) 004002 (month) 004003 (day)	Date of observation
8	301012	Time	004004 (Hour) 004005 (Minutes)	Time of observation
9	008021	Time significance	008021	Value = 26 (time of last known position)
10	301011	Date	004001 (year) 004002 (month) 004003 (day)	Date of last known position coded here; coded missing for fixed station
11	301012	Time	004004 (Hour) 004005 (Minutes)	Time of last known position coded here; coded missing for fixed station
12	008021	Time significance	008021	Value = “missing”
13	301021	Latitude and longitude (high accuracy)	005001 (Lat; high accuracy) 006001 (Lon; high accuracy)	Coarse accuracy descriptors (005002 and 006002 respectively) were used with PDE buoys
14	027004	Alternate latitude (high accuracy)	027004	Coded if Argos is used for location; otherwise coded missing
15	028004	Alternate longitude (high accuracy)	028004	Coded if Argos is used for location; otherwise coded missing
16	007030	Height of station above MSL	007030	
17	001051	Platform Transmitter ID	001051	If Argos is used, Argos ID number;
18	002148	Data collection and/or Location system	002148	1=Argos 2=GPS Coded missing if none
19	001012	Platform drift direction	001012	Coded missing for moored buoys
20	001014	Platform drift speed	001014	Coded missing for moored buoys
21	002040	Method of removing platform direction and speed from current	002040	Coded missing for moored buoys
22	033022	Quality of buoy satellite transmission	033022	0=Good 1=Dubious 3=missing
23	033023	Quality of buoy location	033023	0=Reliable 1=Last known position 2=Dubious 3=missinh
24	033027	Location quality class (range of radius of 66% confidence)	033027	0: >= 1500m 1: 500m to 1500m
25	022063	Total water depth	022063	Mooring depth; otherwise coded missing
26	302021	Waves	022001 (direction of waves) 022011 (period of waves)	

			022021 (height of waves)	
27	302022	Wind waves	022002 (direction wind wv) 022012 (period wind wv) 022022 (height wind wv)	
28	302023	Swell waves	022003 (direction swell wv) 022013 (period swell wv) 022023 (height swell wv)	
29	008081	Type of equipment (observing platform)	008081	(New descriptor, scale=0, ref=0, bits=6) 0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value=3: Equipment = "platform"
30	025026	Battery voltage	025026	(New descriptor, Volts, scale=0, ref=0, bits=6) Platform battery voltage
31	008081	Type of equipment (transmitter)	008081	(New descriptor, scale=0, ref=0, bits=6) 0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value=1: Equipment = "transmitter"
32	025026	Battery voltage	025026	(New descriptor, Volts, scale=0, ref=0, bits=6) Transmitter battery voltage
33	008081	Type of equipment (receiver)	008081	(New descriptor, scale=0, ref=0, bits=6) 0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value=2: Equipment = "receiver"
34	025026	Battery voltage	025026	(New descriptor, Volts, scale=0, ref=0, bits=6) Receiver battery voltage
35	008081	Type of equipment – value Missing = cancel	008081	0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value = "missing"
36	002034	Drogue type	002034	Coded missing for moored buoys
37	022060	Lagrangian drifter drogue status	022060	(New descriptor, scale=0, ref=0, bits=3) 0=detached 1=attached 3=missing Coded missing for moored buoys
38	007070	Drogue depth	007070	Coded missing for moored buoys
39	002190	Lagrangian drifter submergence	002190	Coded missing for moored buoys
40	025086	Depth correction indicator for sub-surface measurements along cable	025086	0=depths are not corrected 1=depths are corrected 3=missing
41	002035	Cable length	002035	Depth of hydrostatic pressure sensor at bottom of cable
42	002168	Hydrostatic pressure of lower end of cable	002168	
43	020031	Ice deposit (thickness)	020031	Ice thickness

44	002038	Method of temperature and/or velocity measurement	002038	e.g. 2=hull contact sensor 8=thermistor chain
45	306004	Digitization, depth/salinity method, depths/salinities/temperatures	002032 (indicator for digit) 002033 (method sal/depth) 103000 (delayed repl 3 desc) 031001 (replication factor) 007062 (depth) 022043 (sea temperature) 022062 (salinity)	Replication factor indicates number of (depth, temp., salinity) data points that are encoded
46	002030	Method of current measurement	002030	
47	306005	Time/duration of current measurement, depths/directions/speeds	002031 (method current) 103000 (delayed repl 3 desc) 031001 (replicationfactor) 007062 (depth) 022004 (direction current) 022031 (speed current)	Replication factor indicates number of (pepth, dir, speed) data points that are encoded
48	007031	Height of barometer above MSL	007031	
49	008081	Type of equipment (sensor)	008081	(New descriptor, scale=0, ref=0, bits=6) 0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value=0: Equipment = “sensor”
50	012064	Instrument temperature	012064	Temperature of air pressure sensor
51	302001	Pressure and pressure change	010004 (pressure at station) 010051 (MSLP) 010061 (3-hour tendency) 010063 (tend. Characteristic)	Mean Seal Level Pressure to be computed based upon pressure at station level and sensor height
52	008081	Type of equipment – value missing = cancel	008081	(New descriptor, scale=0, ref=0, bits=6) 0=sensor 1=transmitter 2=receiver 3=observing system Here coded with value = “missing”
53	007032	Height of sensor above marine deck platform (for temp.&hum. measurement)	007032	Height of thermometer above marine desck
54	007033	Height of sensor above water surface (for temp.&hum. measurement)	007033	Height of thermometer (assumed should be coded with value = 2 metres for PDE buoys)
55	012101	Dry-bulb temperature (scale 2)	012101	Dry-bulb temperature at 2m (012004) was used for PDE buoys
56	012103	Dew-point temperature (scale 2)	012103	
57	013003	Relative humidity	013003	
58	007032	Height of sensor above marine deck platform (for wind measurement)	007032	Real height of anemometer above marine deck
59	007033	Height of sensor above water surface (for wind measurement)	007033	Real height of anemometer above average water surface
60	008082	Artificial correction of sensor height to another value	008082	(New descriptor, scale=0, ref=0, bits=6) 0=sensor height is not corrected 1=sensor height is artificially corrected 7=missing Assumed should be coded to value 1 for PDE buoys

61	007033	Height of sensor above water surface (here height of anemometer to which it is artificially corrected)	007033	Here height of anemometer to which it is artificially corrected Assumed should be coded with value = 10 metres for PDE buoys
62	002169	Anemometer type	002169	e.g. 0=rotor 1=propeller rotor
63	002002	Type of instrumentation for wind measurement	002002	
64	008021	Time significance	008021	Value = 2 (time averaged)
65	004025	Time period in minutes	004025	Value for averaging period (e.g. 10 minutes)
66	011001	Wind direction	011001	Wind direction at 10m (011011) was used with PDE buoys
67	011002	Wind speed	011002	Wind speed at 10m (011012) was used with PDE buoys
68	008021	Time significance	008021	Value = 23 (monitoring period)
69	004025	Time period in minutes	004025	Period during which gust is being monitored prior to observation time
70	011043	Maximum wind gust direction	011043	
71	011041	Maximum wind gust speed	011041	
72	008082	Artificial correction of sensor height to another value (set to missing to reset previous value)	008082	(New descriptor, scale=0, ref=0, bits=6) 0=sensor height is not corrected 1=sensor height is artificially corrected 7=missing Here coded with value = “missing”
73	007033	Height of sensor above water surface (set to missing to cancel previous value)	007033	Value=”missing”: Redefine height to previous level
74	007032	Height of sensor above marine deck platform (for precipitation measurement)	007032	Here height of precipitations
75	004024	Time period in hours	004024	Period during which precipitation is being monitored prior to observation time
76	013011	Total precipitation	013011	Total precipitation during monitoring period
77	007032	Height of sensor above marine deck platform (set to missing to cancel the previous value)	007032	Value = “missing”
78	008021	Time significance	008021	Value = 3 (accumulated)
79	004024	Time period in hours	004024	Period during which global radiation is being accumulated prior to observation time
80	014021	Global radiation, integrated over period specified	014021	
81	008021	Time significance	008021	Value = “missing”
82	025028	Operator or manufacturer defined parameter (#1)	025028	(New descriptor, scale=1, ref=-16384, bits=15) Housekeeping parameter number 1
83	025028	Operator or manufacturer defined parameter (#2)	025028	(New descriptor, scale=1, ref=-16384, bits=15) Housekeeping parameter number 2
84	025028	Operator or manufacturer defined parameter (#3)	025028	(New descriptor, scale=1, ref=-16384, bits=15) Housekeeping parameter number 3
85	***022073***	***Maximum wave height***	***022073***	
86	***022070***	***Significant wave height***	***022070***	***$H_sH_sH_sH_s$ in WAVEOB section 0***
87	***022074***	***Average wave period***	***022074***	***$P_aP_aP_aP_a$ in WAVEOB section 0***
88	***022076***	***Direction from which dominant waves are coming***	***022076***	***d_dd_d in WAVEOB section 0***
89	***022077***	***Directional spread of dominant waves***	***022077***	***d_sd_s in WAVEOB section 0***
90	***022071***	***Spectral peak wave period***	***022071***	***$P_pP_pP_pP_p$ in WAVEOB section 0***
91	***022078***	***Duration of wave record***	***022078***	***D’D’D’D’ in WAVEOB section 1***

92	*022082*	***Maximum non-directional spectral wave density***	*022082*	***$C_mC_mC_m$ in WAVEOB section 2***
93	*022084*	***Band containing maximum non-directional spectral wave density***	*022084*	***n_mn_m in WAVEOB section 2***
94	*025043*	***Wave sampling interval (time)***	*025043*	***SSSS in WAVEOB (I_a=0)***
95	*025044*	***Wave sampling interval (space)***	*025044*	***SSSS in WAVEOB (I_a=1)***
96	*112000*	***Delayed replication of 12 descriptors***	*112000*	***Replication for frequency bands. PDE buoys did not used delayed replication***
97	*031001*	***Replication factor***	*031001*	***Delayed replication therefore added. Replication factor = Number of frequency bands***
98	*022080*	***Waveband central frequency***	*022080*	***$f_nf_nf_n$ in WAVEOB section 1***
99	*201134*	***Add 6 bits to data width***	*201134*	
100	*022096*	***Spectral band width***	*022096*	***Here coded with 10 bits as descriptor requires 4 bits and we have 6 bits added due to previous operation descriptor***
101	*201000*	***Reset data width to normal***	*201000*	
102	*022090*	***Non-directional spectral estimate by wave frequency***	*022090*	***$A_nA_nA_n$ in WAVEOB (I_b=0) section 5***
103	*022086*	***Mean direction from which waves are coming***	*022086*	***$d_{a1}d_{a1}$ in WAVEOB section 4***
104	*022087*	***Principal direction from which waves are coming***	*022087*	***$d_{a2}d_{a2}$ in WAVEOB section 4***
105	*022095*	***Directional spread of individual waves***	*022095*	
106	*022085*	***Spectral wave density ratio***	*022085*	***c_nc_n in WAVEOB section 2***
107	*022088*	***First normalized polar coordinate from Fourier coefficients***	*022088*	***r_1r_1 in WAVEOB section 4***
108	*022089*	***Second normalized polar coordinate from Fourier coefficients***	*022089*	***r_2r_2 in WAVEOB section 4***
109	*022092*	***Directional spectral estimate by wave frequency***	*022092*	***$A_nA_nA_n$ in WAVEOB (I_b=1) section 5***

ANNEX TO PARAGRAPH 5.4.4

High Resolution Radiosonde BUFR (Land, Ship or Mobile)

Table Reference			Element Name	Type & Byte Size (Bits)		Comments
			Identification of launch site and instrumentation.			
0	01	001	WMO Block Number	Numeric	7	
0	01	002	WMO Station Number	Numeric	10	
0	01	011	Ship or mobile land station identifier	CCITT IA5	72	
0	02	011	Radiosonde Type	Code table	8	Code table might need updating
0	02	013	Solar and Infrared radiation correction	Code table	4	Code table might need updating
0	02	014	Tracking technique/status of system used	Code table	7	Code table might need updating
0	02	003	Type of measuring equipment used	Code table	4	Code table might need updating
0	25	061	Software identification number	CCITT IA5	96	Text descriptor
0	01	082	Radiosonde ascension number	Numeric	14	
0	01	081	Radiosonde serial number	CCITT IA5	160	
0	02	067	Radiosonde operating frequency	Hz, Scale-5	15	Frequency at Launch
0	02	095	Type of pressure sensor	Code table	5	
0	02	096	Type of temperature sensor	Code table	5	
0	02	097	Type of humidity sensor	Code table	5	
0	02	081	Type of balloon	Code table	5	
0	02	082	Weight of balloon	Kg, scale 3	12	
0	02	084	Type of gas used in balloon	Code table	4	
?	??	???	Geopotential height calculation	Code table	4	1 – from pressure 2 – from GPS Height
			Date/time of launch			
0	08	021	Time significance	Code table	5	Nominal hour?
0	04	001	Year } 3 01 011	Year	12	
0	04	002	Month } 3 01 011	Month	4	
0	04	003	Day } 3 01 011	Day	6	
0	04	004	Hour } 3 01 013	Hour	5	
0	04	005	Minute } 3 01 013	Minute	6	
0	04	006	Second } 3 01 013	Second	6	
			Horizontal and vertical coordinates of launch site.			
0	05	001	Latitude (High Accuracy)	Degree	25	
0	06	001	Longitude (High Accuracy)	Degree	26	
0	07	030	Height of station above MSL	M, scale 1	17	
0	07	031	Height of barometer above MSL	M, scale 1	17	
0	07	007	Height of radiosonde release above MSL	M	15	
			Surface information reported with vertical sounding			
0	08	002	Vertical significance (surface obs)	Flag	6	
0	10	004	Pressure	Pa, scale -1	14	Need to change scale?
0	12	101	Temperature (dry bulb)	K, scale 2	16	
0	13	003	Relative humidity	%, scale 0	7	

0	11	001	Wind Direction	Deg,scale 0	9	
0	11	002	Wind Speed	m/s, scale 1	12	
0	08	002	Vertical significance	Flag	6	Cloud Ob
0	20	011	Cloud amount (low or middle $N_{h)}$	Code table	4	
0	20	013	Height of base of cloud (h)	m, scale -1	11	
0	20	012	Cloud Type (Low)	Code table	6	
0	20	012	Cloud Type (Medium)	Code table	6	
0	20	012	Cloud Type (High)	Code table	6	
0	08	002	Vertical significance (missing values)	Flag	6	
			Present weather?			
0	22	043	Sea/water temp (ship stations)	K, scale 2	15	
			Vertical sounding data			***Repeated section***
1	01	000	Delayed replication of 1 descriptor			
0	31	002	Extended delayed descriptor replication factor	Numeric	16	
0	04	086	Long time period or displacement (since launch time)	Second	15	
0	08	042	Extended vertical sounding significance	Flag table	18	
0	10	009	Geopotential height	gpm, scale0	17	
0	05	015	Latitude displacement since launch site (high accuracy)	Degree, Scale 5	25	Displacement or actual? Is resolution too much 5 decimal places?
0	06	015	Longitude displacement since launch site (high accuracy)	Degree, Scale 5	26	
0	12	101	Temperature/dry bulb	K, scale 2	12	
0	13	003	Relative Humidity	%, scale 0	7	
0	11	001	Wind direction	Degree true	9	
0	11	002	Wind Speed	m/s, scale 1	12	

COMMENTS:

The template could have one of two possible purposes, and the extent of the required changes depends on the intended purpose of the template.

If the template is intended to be used for local archival of data or for the transmission of minimally processed data from the observing site to a national centre for further processing then only a few minimal changes would be recommended.

On the other hand, if the template is intended for the international exchange of data, much more extensive changes would be necessary.

Minimal changes recommended if the template is intended for local archive or for transmission to a national centre, include:

1. The nominal data time is reported in Section 1 of the BUFR message. The first time included in the template, preceded by time significance descriptor 0 08 021 should be the launch time. The value associated with the 0 08 021 descriptor should be 18 (= Launch time).

2. Although not absolutely necessary, the meeting would recommend that the surface pressure, temperature, relative humidity, and wind direction and speed would be better represented as a surface level (bit 1 of the value associated with descriptor 0 08 042, extended vertical sounding significance) within the main data replication [Vertical sounding data *Repeated section*]

3. The pressure must be included in the main data replication.

4. The number of descriptors to be repeated in the main data replication is incorrect. It is given as one (1 01 000) and should be ten (1 10 000) when pressure is included, or eleven (1 11 000) if both pressure and dew point are included.

If the template is intended to be used for the international exchange of data, then further major changes would be required including

1. The addition of dew point temperature within each level of the vertical sounding data.
2. The addition of wind shear data as required by the current rules for the international exchange of upper air data.

The meeting would also comment that this proposed template has much in common with the existing template TM309052 and largely duplicates the functionality of table D sequence 3 09 052. Sequence 3 09 052 has the same capability to handle high-resolution data as the proposed template. The additional metadata descriptors could be prep ended to descriptor 3 09 052 in section 3 of the BUFR message.

Questions implied by the proposed template include also:

1. The comment about changing scale against descriptor 0 10 004 implies some concern about the scale. The scale of descriptor 0 10 004 is -1 (10 Pa, 0.1hPa) which seems to be sufficiently accurate. If more accuracy is required, then either change scale and change data width descriptors should be used or a formal request for a new, higher resolution descriptor should be made to the ET-DR&C.
2. There is a comment “Present Weather?”. It is unclear what this comment is intended to convey. If the purpose is to ask what descriptor can be used to describe the weather at the time of launch, then 0 20 003 can be used.
3. There is a query “Displacement or actual” against descriptors 0 05 015 and 0 01 016 (Latitude and longitude displacement) as to the meaning. These two descriptors are displacements from the launch point that is the difference between the current location and the launch point.
4. There is a query against the resolution (5 decimal places, 0.00001 deg, approximately 1m) of descriptors 0 05 015 and 0 06 015. This was requested, by data users in order to cope with constantly improving technology.

ANNEX TO PARAGRAPH 5.5

For urgent validation

Proposed METAR/SPECI and TAF templates

Proposed additions to BUFR Table D

F X Y	Reference	Element/Sequence name	METAR/SPECI/TAF Code group(s)
		(Main part of METAR/SPECI), replacing 3 07 011	
3 07 045	0 01 063	ICAO location indicator	CCCC
	0 08 079	Aviation product status (routine, special)	**METAR SPECI COR**
	0 02 001	Type of station	(**AUTO**)
	3 01 011	Year, month, day	YY
	3 01 012	Hour, minute	GGgg
	3 01 024	Latitude-longitude (coarse accuracy), height of station	
	0 07 032	Height of sensor above local ground = 10m	
	0 11 001	Wind direction	ddd
	0 11 016	Extreme counterclockwise wind direction of a variable wind	$d_nd_nd_n$
	0 11 017	Extreme clockwise wind direction of a variable wind	$d_xd_xd_x$
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 083	Wind speed (km/h)	ff
	0 11 084	Wind speed (knots)	ff
	0 11 002	Wind speed (m/s)	ff
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 085	Maximum wind speed (gusts) (km/h)	f_mf_m
	0 11 086	Maximum wind speed (gusts) (knots)	f_mf_m
	0 11 041	Maximum wind speed (gusts) (m/s)	f_mf_m
	0 08 054	Qualifier for wind speed or wind gusts = Missing (cancel)	
	0 07 032	Height of sensor above local ground = 2m	
	0 12 023	Temperature (Celsius)	T´T´
	0 12 024	Dew point (Celsius)	$T'_dT'_d$
	0 07 032	Height of sensor above local ground = missing (cancel meaning)	
	0 10 052	Altimeter setting (QNH)	$P_HP_HP_HP_H$
	0 20 009	General Weather Indicator TAF/METAR	**CAVOK**
		(METAR/SPECI visibility)	
3 07 046	0 20 060	Prevailing visibility	VVVV
	1 03 000	Delayed replication of 3 descriptors	
	0 31 001	Number of replication (up to 2)	
	0 05 021	Direction of visibility observed	Dv
	0 20 061	Minimum visibility	VVVV
		(METAR/SPECI/TAF clouds)	
3 07 047	1 05 000	Delayed replication of 5 descriptor	
	0 31 001	Number of replications	
	0 08 002	Vertical significance	
	0 20 011	Cloud amount	$N_sN_sN_s$
	0 20 012	Cloud type	CC
	0 20 013	Height of base of cloud (m)	$h_sh_sh_s$
	0 20 092	Height of base of cloud (feet)	$h_sh_sh_s$
	0 20 002	Vertical visibility (m)	**VV**$h_sh_sh_s$

F X Y	Reference	Element/Sequence name	METAR/SPECI/TAF Code group(s)
	0 20 091	Vertical visibility (feet)	**VV**$h_sh_sh_s$
		(Trend type forecast), replacing 3 07 018	
3 07 048	0 08 016	Change qualifier for trend type forecast	TTTTT **NOSIG**
	1 02 000	Delayed replication of two descriptors	
	0 31 001	Number of replications (0, 1 or 2)	
	0 08 017	Qualifier for time of forecast change	TT
	3 01 012	Time of change	GGgg
	1 04 000	Delayed replication of four descriptors	
	0 31 000	Short delayed replication count (0 or 1)	
	0 07 032	Height of sensor above local ground = 10m	
	0 11 001	Wind direction	ddd
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 083	Wind speed (km/h)	ff
	0 11 084	Wind speed (knots)	ff
	0 11 002	Wind speed (m/s)	ff
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 085	Maximum wind speed (gust) (km/h)	f_mf_m
	0 11 086	Maximum wind speed (gust) (knots)	f_mf_m
	0 11 041	Maximum wind speed (gusts) (m/s)	f_mf_m
	0 08 054	Qualifier for wind speed or wind gusts = Missing (cancel)	
	0 07 032	Height of sensor above local ground = missing (cancel meaning)	
	0 20 009	General weather indicator	**CAVOK NSW NSC SKC**
	1 01 000	Delayed replication of one descriptor	
	0 31 000	Short delayed replication count (0 or 1)	
	0 20 060	Prevailing visibility	VVVV
	3 07 014	Weather intensity and phenomena	w'w'
	3 07 015	Clouds	$N_sN_sN_sh_sh_sh_s$
		(Sea conditions WT_sT_s/SS')	
3 07 049	1 02 000	Delayed replication of 2 descriptors	
	0 31 000	Short delayed replication factor (0 or 1)	
	0 22 043	Sea/water temperature	T_sT_s
	0 22 021	Height of waves	S'
		(Runway state $R_RR_RE_RE_RC_Re_Re_RB_RB_R$)	
3 07 050	1 01 000	Delayed replication of one descriptor	
	0 31 000	Short delayed replication factor (0 or 1)	
	0 20 085	General condition of runway	**SNOCLO**
	1 02 000	Delayed replication of two descriptors	
	0 31 001	Number of replications	
	0 01 064	Runway designator	R_RR_R
	0 20 085	General condition of runway	**CLRD//**
	1 05 000	Delayed replication of 5 descriptors	
	0 31 001	Number of replications	
	0 01 064	Runway designator	R_RR_R
	0 20 086	Runway deposits	E_R
	0 20 087	Runway contamination	C_R
	0 20 088	Depth of runway deposits	e_Re_R
	0 20 089	Runway friction coefficient	B_RB_R

F X Y	Reference	Element/Sequence name	METAR/SPECI/TAF Code group(s)
		(Full METAR/SPECI), *replacing 3 07 021*	
3 07 059	3 07 045	Main part of METAR/SPECI data	
	3 07 046	Visibility	$VVVVD_v$
	3 07 013	Runway visual range	$\mathbf{R}D_RD_RV_RV_RV_RV_R$
	3 07 014	Weather intensity and phenomena	w'w'
	3 07 047	Clouds	$N_sN_sN_sh_sh_sh_s$
	3 07 016	Recent weather phenomena	**RE**w'w'
	3 07 017	Runway shear	$\mathbf{WS\ RWY}D_RD_R$
	3 07 049	Sea conditions	$\mathbf{W}T_sT_s$/SS'
	3 07 050	Runway state	$R_RR_RE_RC_Re_Re_RB_RB_R$
	1 01 000	Delayed replication of one descriptor	
	0 31 001	Replication count (0 to 3 normally)	
	3 07 048	Trend type forecast	
		(Aerodrome forecast identification and time interval)	
3 07 052	0 01 063	ICAO location identifier	CCCC
	0 08 039	Time significance – Issue time	
	3 01 011	Year, Month, Day	YY
	3 01 012	Hour, Minute	GGgg
	0 08 079	Aviation product status	**COR CNL** **AMD NIL**
	3 01 011	Year, Month, Day (start of forecast)	Y_1Y_1
	3 01 012	Hour, Minute	G_1G_1
	3 01 011	Year, Month, Day (end of forecast)	Y_2Y2
	3 01 012	Hour, Minute	G_2G_2
	3 01 024	Latitude, Longitude, Height of station	
		(Forecast weather at an aerodrome)	
3 07 053	0 07 032	Height of sensor above local ground = 10m	
	0 11 001	Wind direction	ddd
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 083	Wind speed (km/h)	ff
	0 11 084	Wind speed (knots)	ff
	0 11 002	Wind speed (m/s)	ff
	0 08 054	Qualifier for wind speed or wind gusts	**P**
	0 11 085	Maximum wind speed (gusts) (km/h)	f_mf_m
	0 11 086	Maximum wind speed (gusts) (knots)	f_mf_m
	0 11 041	Maximum wind speed (gusts) (m/s)	f_mf_m
	0 08 054	Qualifier for wind speed or wind gusts = Missing (cancel)	
	0 07 032	Height of sensor above local ground = missing (cancel meaning)	
	0 20 009	General weather indicator	**CAVOK** **NSW** **NSC** **SKC**
	0 20 060	Prevailing visibility	VVVV
	3 07 014	Weather	w'w'
	3 07 047	Cloud layer(s)	$N_sN_sN_sh_sh_sh_s$

		(Forecast of extreme temperatures)	
3 07 054	0 07 032	Height of sensor above local ground = 2m	
	0 08 039	Time significance = 1 (Forecast time of maximum temperature)	
	0 04 003	Day	
	0 04 004	Hour	G_FG_F
	0 08 023	First order statistics = 3 (Minimum)	
	0 12 023	Temperature (Celsius)	T_FT_F
	0 08 039	Time significance = 2 (Forecast time of minimum temperature)	
	0 04 003	Day	
	0 04 004	Hour	G_FG_F
	0 08 023	First order statistics = 2 (Maximum)	
	0 12 023	Temperature (Celsius)	T_FT_F
	0 08 023	First order statistics = Missing (cancel)	
	0 08 039	Time significance = missing (to cancel the previous value)	
	0 07 032	Height of sensor above local ground = missing (cancel meaning)	
		(Change indicator and forecast changes)	
3 07 055	0 33 045	Probability of following event	C_2C_2
	0 08 016	Change qualifier for an aerodrome forecast	TTTTTT
	0 04 003	Start of the change (day)	
	3 01 012	Start of time change	GG GGgg
	0 04 003	End of the change (day)	
	3 01 012	End of time change	G_eG_e
	3 07 053	Forecast conditions during or after change	
		(Aerodrome forecast)	
3 07 056	3 07 052	Identification and time interval	
	3 07 053	Forecast	
	3 07 054	Extreme temperatures forecast	
	1 01 000	Delayed replication of one descriptor	
	0 31 001	Replication factor	
	3 07 055	Forecast change	

Proposed additions to BUFR/CREX table B.

Table reference	Element name	BUFR				CREX		
F X Y		Unit	Scale	Reference	Width	Unit	Scale	Width
0 08 039	Time significance (Aviation forecast)	Code table	0	0	6	Code table	0	2
0 08 054	Qualifier for wind speed or wind gusts	Code table	0	0	3	Code table	0	1
0 11 083	Wind speed	km h^{-1}	0	0	9	km h^{-1}	0	3
0 11 084	Wind speed	knot	0	0	8	knot	0	3
0 11 085	Maximum wind gust speed	km h^{-1}	0	0	9	km h^{-1}	0	3
0 11 086	Maximum wind gust speed	knot	0	0	8	knot	0	3
0 12 023	Temperature	Celsius	0	-99	8	Celsius	0	2
0 12 024	Dew point	Celsius	0	-99	8	Celsius	0	2
0 20 060	Prevailing horizontal visibility	m	0	0	10	m	0	4
0 20 085	General condition of runway	Code table	0	0	4	Code table	0	1
0 20 086	Runway deposits	Code table	0	0	4	Code table	0	1
0 20 087	Runway contamination	Code table	0	0	4	Code table	0	1
0 20 088	Depth of runway deposits	m	3	0	12	m	0	4
0 20 089	Runway friction coefficient	Code table	0	0	7	Code table	0	2
0 20 092	Height of base of cloud	Feet	-2	0	10	-2	0	3
0 20 091	Vertical visibility	Feet	-2	0	10	-2	0	3
0 20 061	Minimum horizontal visibility	m	0	0	10	m	0	4

Proposed additions to BUFR Code/Flag tables

0 08 039	
Time significance (Aviation forecast)	
Code figure	
0	Issue time of forecast
1	Forecast time of maximum temperature
2	Forecast time of minimum temperature
3…62	Reserved
63	Missing
0 08 054	
Qualification of wind speed or wind gusts	
0	Wind speed or gust is as reported
1	Wind speed is greater than that reported (**P** in **METAR/TAF/SPECI**)
2…6	Reserved
7	Missing
0 20 086	
Runway deposits	
Code figure	
0	Clear and dry
1	Damp
5	Wet snow
6	Slush
7	Ice
8	Compacted or rolled snow
9	Frozen ruts or ridges
10-14	Reserved
15	Missing or not reported

Proposed additions to BUFR Code table 0 08 079

0 08 079	
Product status	
Code figure	
6	Special report (**SPECI**)
7	Corrected special report (**SPECI COR**)
8…14	Reserved
15	Missing or not applicable

ANNEX TO PARAGRAPH 6.1.3

Data and product identification

Although ECMWF is not directly connected to the GTS, the data received form Exeter and Offenbach are GTS data. The system shows the following bulletins received on 20060424.

Israel:

TEMP -	IUSDA01	LLBD type/subtype 02/04
PILOT -	IUSDA02	LLBD type/subtype 02/01
SYNOP-	ISMD01	LLBD type/subtype 00/02
	ISMD42	LLBD type/subtype 00/02
	ISID21	LLBD type/subtype 00/01
	ISID42	LLBD type/subtype 00/01

Japan:

SYNOP-	ISMC01	RJTD type/subtype 00/02
	ISIC01	RJTD type/subtype 00/02
SHIP	ISSC01	RJTD type/subtype 01/00
	ISSA02	RJTD type/subtype 01/00
	ISSB02	RJTD type/subtype 01/00
	ISSC02	RJTD type/subtype 01/00
	ISSK02	RJTD type/subtype 01/00
TEMP -	IUKC[1-6]	RJTD type/subtype 02/04
	IUFC[2-6]	RJTD type/subtype 02/04
TEMP-SHIP	IUK[A,D][10,15]	RJTD type/subtype 02/05
	IUF [A,D][10,15]	RJTD type/subtype 02/05

A1 =F should not be used

TESAC/BATHY	IOCS11	RJTD type/subtype 31/05
CLIMAT SYNOP		
CLIMAT TEMP		

Netherlands:

AWS	ISAD40	EDBH type 0 Edition 3

USA:	ISAT40	KBOU type 2 Edition 3 surface pressure, MSL pressure, RH

Czech Republic:

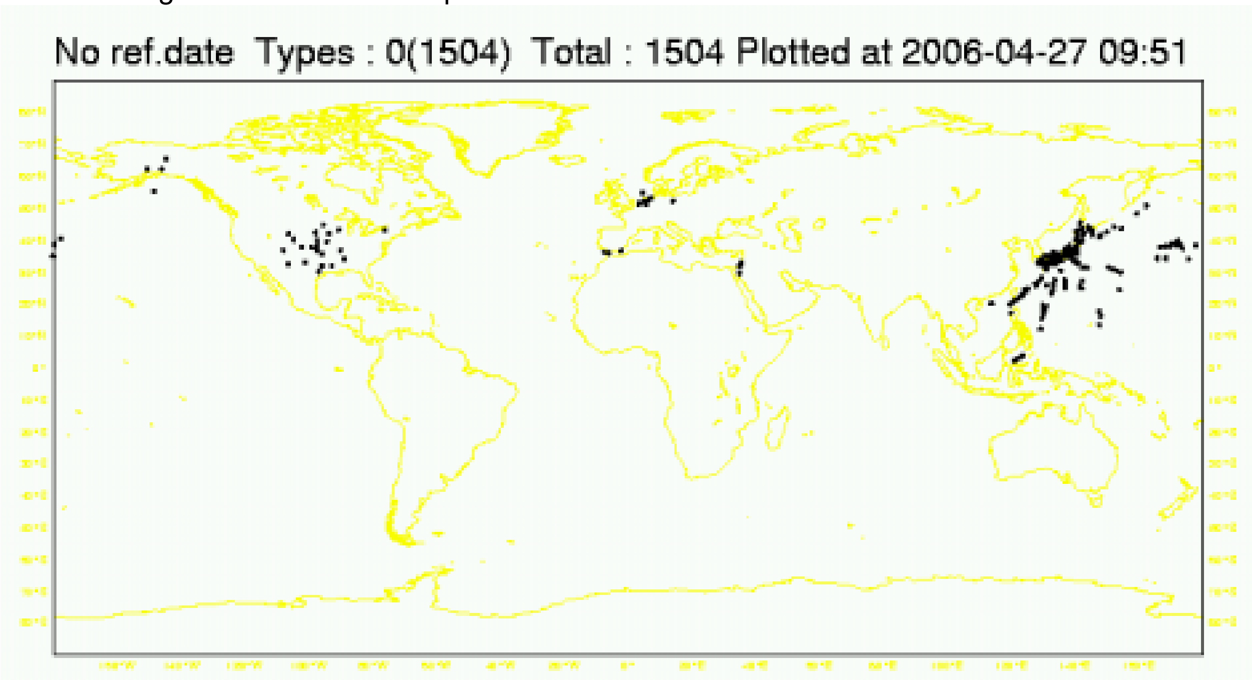
TEMP	IUSD40	OKLI type 02 Edition 3

Jordan:

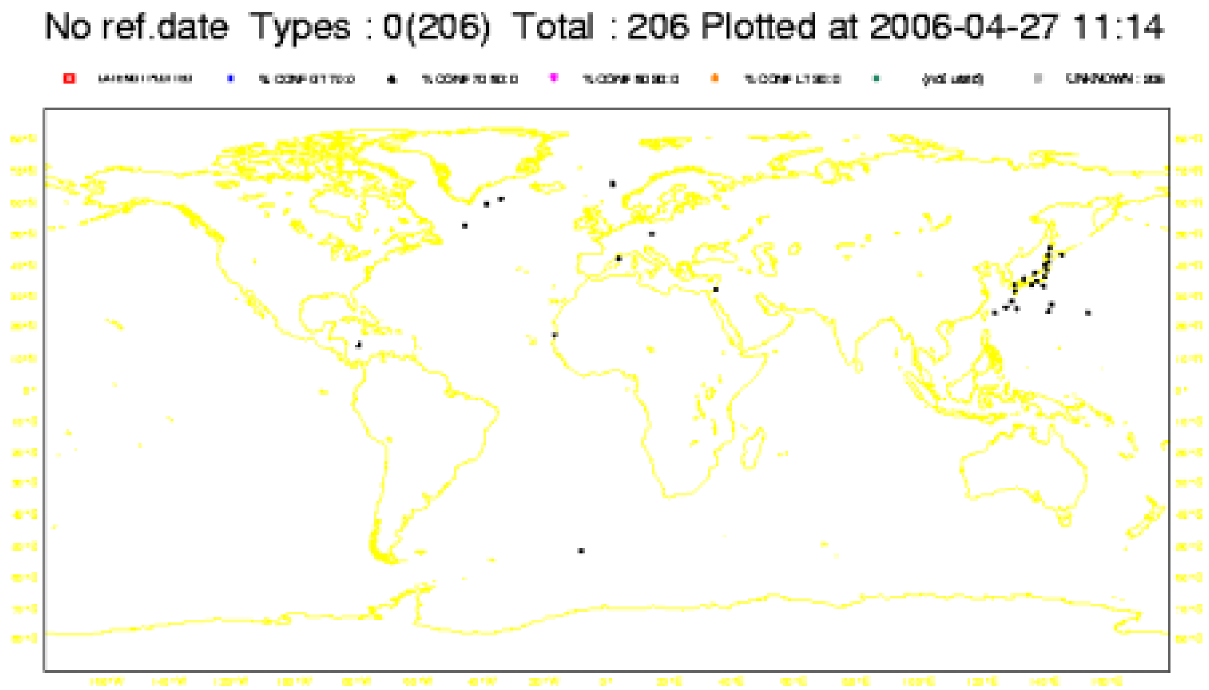
SYNOP	ISMD01	OJAM problems during decoding
	ISID01	OJAM problems during decoding

Availability of migration data and products on GTS

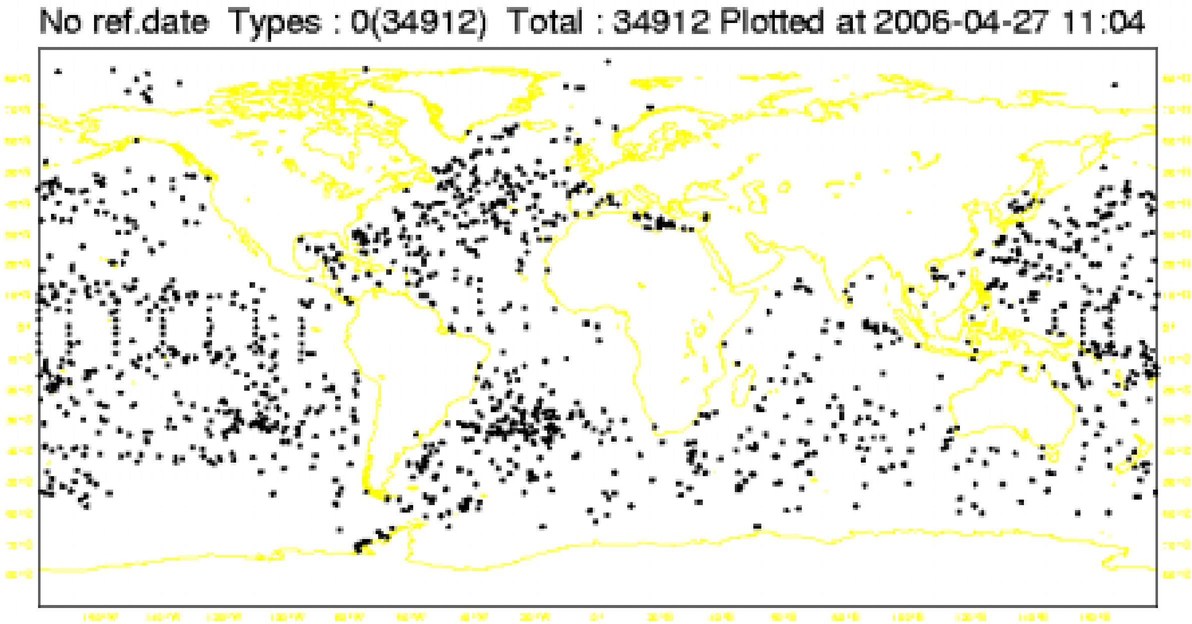
Data coverage of SYNOP land/ship observations



Data coverage TEMP land/ship



Buoy data from Migration Plan Category 4:



ANNEX TO PARAGRAPH 6.1.4.1

Volume of the data

The following table is based on data on 2006/04/28.

Data type	Bulletin header	Volume in bytes
SYNOP	ISIC[01], ISMC[01]	74105
SHIP	ISSB[02], ISSC[01-02], ISSD[02]	30945
TEMP	IUFC[01-06], IUKC[01-06]	73936
TEMP SHIP	IUFA[10,15], IUFD[10,15], IUFL[10,15], IUKA[10,15], IUKD[10,15], IUKL[10]	21753
BUOY	IOBC[01]	7656
BATHY/TESAC	IOSC[01,11]	5609
Total		214004
SAREP/SATOB	IUCN[41-43,51-61,71-78], IUCS[41-45,51-61,71-83]	2668101

ANNEX TO PARAGRAPH 6.1.4.2

Report on the status of cloud-motion-winds data of FY-2C satellite disseminated on GTS in BUFR.

Volume of the data: The following table is based on data on 2006/04/18.

(1) Segmented bulletins

TTAAII	CCCC	YYGGgg	BBB	Volume in bytes
infrared channel				
IUCX01	BGBA	180500	PAA, PAB, PAC, PAD	15000 for each
			PZE	8971
IUCX01	BGBA	181100	PAA, PAB, PAC, PAD	15000 for each
			PZE	8393
IUCX01	BGBA	181700	PAA, PAB, PAC	15000 for each
			PZD	14810
IUCX01	BGBA	182300	PAA, PAB, PAC, PAD	15000 for each
			PZE	2871
water vapor channel				
IUCX02	BGBA	180500	PAA, PAB, PAC, PAD, PAE	15000 for each
			PZF	3204
IUCX02	BGBA	181100	PAA, PAB, PAC, PAD, PAE	15000 for each
			PZF	2490
IUCX02	BGBA	181700	PAA, PAB, PAC	15000 for each
			PZD	13592
IUCX02	BGBA	182300	PAA, PAB, PAC, PAD	15000 for each
			PZE	14967
Total				549,298

(2) Bulletins with no segmentation (Only send to Tokyo according to their requirements)

TTAAII	CCCC	YYGGgg	Volume in bytes
infrared channel			
IUCX01	BGBA	180500	68867
IUCX01	BGBA	181100	68289
IUCX01	BGBA	181700	59731
IUCX01	BGBA	182300	62767
water vapor channel			
IUCX02	BGBA	180500	78075
IUCX02	BGBA	181100	77361
IUCX02	BGBA	181700	58513
IUCX02	BGBA	182300	74863
			548,466

Template: Now the data are encoded in BUFR using a national template (without quality control information), the descriptors are as follows:

0-01-007
0-02-023
3-01-011
3-01-012
3-01-011
3-01-012
0-08-003
1-09-000
0-31-002
3-01-023
2-01-131
2-02-129
0-10-004
0-12-001
2-02-000
2-01-000
0-11-001
0-11-002

ANNEX TO PARAGRAPH 6.1.4.3

Outline of the National Migration Plan (Draft) of CMA

1 Basic principles

(1) The plan is drafted based on the WMO migration plan, and follows its basic principles.
(2) The migration of CMA would be implemented by the Migration Steering Group based on this plan. The detailed migration scheme would be constituted in addition by the group.
(3) The migration would be the complete migration, which means the data producers would migrate at the end. The migration would have maneuverability by stages.
(4) Whereas the complexity and the extensive impacts of the migration and to guarantee the success of migration, all core software systems of migration would be developed and deployed by CMA.
(5) Besides the core software systems, all local systems would be migrated by local meteorological offices themselves, but sufficient migration period must be insured.
(6) The migration is not an isolated work. It should be made overall plans and take all factors into consideration. Especially in the construction of existing and intending systems, the ability of handling TDCF data must be considered.

2 Migration process

2.1 Phase 1 (2006-2010)

The migration would only be implemented at the national level and it will be the responsibility of RTH Beijing including GTS distribution. This is the obligator and basic goal.

(a) international telecommunication system (RTH Beijing)

- The regulations (bulletin headers, etc) would be defined.
- The ability of handling TDCF data would be constructed: code conversion, collecting, dissemination, compilation, monitoring and request functions, dual transmission of TAC and TDCF.
- GTS distribution of CMA observations in BUFR (converted from TAC).

(b) national data storage and application systems

- MDSS (national Meteorological Data Storage System): the decoding and storage of TDCF data.
- Other application systems: interface with MDSS to get data, avoid decoding original data by themselves.

2.2 Phase 2 (2008-2014)

The TDCF data would be distributed to local meteorological offices (7 regional level offices, 31 provincial level offices, more than 300 city level offices, more than 2100 county level offices) and decoded, stored and applied locally.

(a) national telecommunication system and data service system

- Distribute TDCF data to local meteorological offices through the national satellite broadcasting system: disseminating and monitoring.
- Distribute TDCF data to other national organizations: disseminating and monitoring.

(b) local telecommunication systems and data service systems

- Receive TDCF data distributed by the national telecommunication system: receiving and monitoring.
- Distribute TDCF data to other local organizations: disseminating and monitoring.

(c) local data storage and application systems

- Decoding, storing and applying TDCF data locally.

2.3 Phase 3 (2008-2015)

BUFR reports of observations would be produced and disseminated at each observation site and would be collected and compiled at the concentration sites or CMA Headquarters for GTS and national distribution.

(a) observation sites

- The regulations (templates, bulletin headers, etc) would be defined.
- CREX is excluded whereas the bandwidth of national telecommunication system.
- All TAC observations (WMO categories and CMA specific categories) and some national-standard format observations would be migrated.
- BUFR would be the only market standard for intending automatic platform observation system.
- Product BUFR reports: coding, disseminating and monitoring; ternary dissemination of TAC, TDCF and national-standard format.

(b) concentration sites

- Handle TDCF data: collecting, compiling, disseminating and monitoring.
- Provide BUFR input interface for observation sites of its responsibility.

(c) local telecommunication systems

- Disseminate TDCF data to national telecommunication system: collecting, disseminating and monitoring.

(d) national telecommunication system

- Receive TDCF data disseminated by local telecommunication systems: receiving, disseminating and monitoring.

3 Potential core software systems of migration

(a) Basic migration software: encoding/decoding, code conversion, etc.
(b) International telecommunication system (RTH Beijing)
(c) MDSS (national Meteorological Data Storage System)
(d) National telecommunication system
(e) National and local data service systems
(f) MICAPS (Meteorological Information Combine Analysis and Process System)
(g) Encoding software system for each type of observations to be migrated
(h) Data concentration software system

4 National training

(a) Three levels of training suggested in the WMO Migration Plan
(b) Training of each core migration software system

Annex

Code Migration Schedule of CMA

Category →	**Cat.1: common**	**Cat.2: satellite observations**	**Cat.3: aviation**	**Cat. 4: maritime**	**Cat. 5: miscellaneous**	**Cat. 6: almost obsolete**
Lists of → Traditional code forms **Schedule ↓**	SYNOP PILOT TEMP CLIMAT CLIMAT TEMP	SATOB[1]	METAR, SPECI, TAF, ROFOR[2] AMDAR	TESAC[3]	No relevant codes	No relevant codes
Start experimental Exchange	2007 for SYNOP 2008 for others	2006	2007 for AMDAR			
Start operational exchange	2009		2008 for AMDAR			
Migration complete	2010		2010 for AMDAR			

Notes:

1) The no relevant codes in CMA are eliminated from the schedule table for simplicity.

2) Remarks

[1]: The cloud-motion-winds product of FY-2C satellite is the only satellite observations created and distributed by CMA. It’s only in BUFR.

[2]: The migration of METAR, SPECI, TAF and ROFOR would be implemented by the General Administration of Civil Aviation of China.

[3]: The migration of TESAC would be implemented by the National Oceanic Administration of China.

ANNEX TO PARAGRAPH 6.1.5

Approved BUFR Table D descriptors for U.S. Radiosonde Replacement System (RRS):
Operational
3-09-060 – (Radiosonde complete registration and surface observation)
3-09-061 – (Raw PTU)
3-09-062 – (Raw GPS unsmoothed wind)
3-09-063 – (Raw GPS smoothed wind)
3-09-064 – (Processed PTU)
3-09-065 – (Processed GPS)
3-09-066 – (Standard and significant levels)

ANNEX TO PARAGRAPH 6.1.6

WMC Melbourne started operational dissemination of SYNOP bulletins for Australia and Papua New Guinea on 4 May 2006. The product identification is as follow:

Data type	BUFR	TAC	CCCC	Time Group
SYNOP	ISMS01	SMAA01	AMMC	00 06 12 18
	ISMS02	SMAA80	AMMC	00 06 12 18
	ISMK01	SMAU01	AMMC	00 06 12 18
	ISMK02	SMAU02	AMMC	00 06 12 18
	ISMK03	SMAU03	AMMC	00 06 12 18
	ISMK04	SMAU04	AMMC	00 06 12 18
	ISMK05	SMAU40	AMMC	00 06 12 18
	ISMG01	SMNG01	AMMC	00 06 12 18
	ISMG02	SMNG40	AMMC	00 06 12 18
	ISIS01	SIAA21	AMMC	03 09 15 21
	ISIS02	SIAA80	AMMC	03 09 15 21
	ISIK01	SIAU21	AMMC	03 09 15 21
	ISIK02	SIAU22	AMMC	03 09 15 21
	ISIK03	SIAU23	AMMC	03 09 15 21
	ISIK04	SIAU24	AMMC	03 09 15 21

Annex to paragraph 6.1.7

The ideas and propositions described still need to be discussed among the Brazilian meteorological centers, so they must not be seen as definitive.

Brazil national migration plan

Two meteorological institutions of Brazil are working in the migration to table driven code forms. The first one is the INMET (National Institute of Meteorology). The INMET is the official meteorological center of Brazil, under the agriculture ministry and official representative to the WMO. The INMET manages the synoptic observation network and the GTS communications. The second center is the CPTEC, Center for Weather Forecast and Climatic Analysis, a division of the INPE, the National Institute for Space Research. The INPE is a research, education and operational institute under the ministry of Science and Technology. The CPTEC is primarily a center for numerical modeling, and runs several numerical models for weather forecast and climatic analysis. It also has a network of automated data collecting platforms, and makes satellite-derived products, like atmospheric soundings and satellite winds.

Both institutions are cooperating to perform the migration to table driven code forms in Brazil, and understand that there is a necessity to extend this work to other countries in South America. Several initiatives are being performed in both institutions. In INMET a web page is being developed with some PHP routines for BUFR on-line decoding and coding. The CPTEC/INPE is preparing the free distribution of his decoders, and is converting global GTS data in TAC format to BUFR for further distribution to other institutions. In two months there will be some training courses in CPTEC, and the objective is to organize them in a regular basis. Several of CPTEC's data-products have been converted to BUFR and GRIB, and are ready for GTS distribution.

In addition, several other ideas for the Brazilian and South America migration plan are being discussed. One idea is to convert all TAC data to BUFR before GTS ingesting. This can be done only for Brazilian data or for all South America data. Another idea is to centralize the GTS data production and ingesting, using tools like a web page for BUFR coding. Brazilian stations can use a page hosted in Brasilia, and other countries of South America can use the same site or install the software on his own meteorological center.

More details are given below about each initiative that is being performed.

Implementation and use of BUFR universal decoder software.

In the INMET some routines in PHP have been developed to decode and encode BUFR observations. The objective is to provide a web-page where someone can submit a BUFR message to decode it, or submit meteorological data to encode a BUFR message. The PHP routines are ready and working, with some tests performed to decode BUFRs messages from CPTEC and other Brazilian centers. The web interface page is under development.

In the CPTEC the data assimilation team developed its own FORTRAN routines to BUFR decoding/encoding. These routines are being used to decode BUFRs from GTS for data assimilation purposes, and to encode the CPTEC´s data for future GTS dissemination. These routines will be freely distributed, and the CPTEC/INPE intends to develop a home-page for the distribution and instructions for use and installation.

Production and experimental exchanges of data in BUFR

The CPTEC is an important data provider in South America. These data includes the automated network of data collecting platforms, the numerical models outputs, the satellite-derived products and imagery. Most of these data are available in BUFR and GRIB format although still not being distributed by the GTS. Experimental dissemination is underway through the IDD (Internet Data Distribution) network, and operationally through the FTP server. Soon this data will be on the GTS.

Global data in TAC received in the CPTEC/INPE from the GTS are being converted to BUFR using programs from ECMWF. At each 6 hours these data are being sent to institutions in Brazil that need them for data assimilation purposes.

Training

The CPTEC is providing several courses in the CPTEC/INPE training facilities. In July there will be courses related to meteorological data. One of them will be specific to the GTS and the telecommunication codes. Another one will be about the BUFR format, the migration and the use of universal decoders. These courses aim to people from meteorological centers and universities. With the availability of GTS data to universities through the IDD (Internet Data Distribution), this information is being required by a growing number of researches, teachers and students.

We understand that training, data dissemination and software freely available for universities and meteorological community are key factors to establish the BUFR format as a standard with greater utilization. The availability of a trained workforce in the Brazilian universities is an advantage for governmental meteorological centers.

ANNEX TO PARAGRAPH 6.2.3

Code Migration Schedule Status Update:

Category →	**Cat.1: common**	**Cat.2: satellite observations**	**Cat.3[(1)]: aviation**	**Cat. 4: maritime**	**Cat. 5[(2)]: miscellaneous**	**Cat. 6[(2,4)]: obsolete**
Lists of → Traditional code forms ***Schedule ↓***	SYNOP SYNOP MOBIL PILOT PILOT MOBIL TEMP TEMP MOBIL TEMP DROP CLIMAT CLIMAT TEMP	SAREP SATEM SARAD SATOB	METAR SPECI TAF ~~*CODAR*~~ AMDAR ~~*WINTEM*~~ ~~*ARFOR*~~ ~~*ROFOR*~~	BUOY TRACKOB BATHY TESAC WAVEOB SHIP CLIMAT SHIP PILOT SHIP TEMP SHIP CLIMAT TEMP SHIP	RADOB ~~*RADREP*~~ IAC IAC FLEET GRID*(to GRIB)* ~~*MAFOR*~~ ~~*HYDRA*~~ ~~*HYFOR*~~ RADOF	ICEAN GRAF NACLI etc. SFAZI SFLOC SFAZU ROCOB ROCOB SHIP *CODAR* *WINTEM* *ARFOR* *ROFOR* *RADREP* *MAFOR* *HYDRA* *HYFOR*
Start experimental Exchange[(3)]	**Nov. 2002** for some data (AWS SYNOP, TEMP USA)	Current at some Centres	**2007** **2002** at some Centres for AMDAR	**2005** **2003** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2004**	Not applicable
Start operational exchange[(3)]	**Nov. 2005**	Current at some Centres	**2008** **2003** for AMDAR	**2007** **2003** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2006**	Not applicable
Migration complete	**Nov. 2010**	**Nov. 2006**	**2016** **2006** for AMDAR	**2012** **2008** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2008**	Not applicable

Notes:

(1) Aviation Codes require ICAO coordination and approval.

(2) For categories 5 consider that codes need to be reviewed in order to decide whether or not they should be migrated to BUFR/CREX. Codes in category 6 are not to be migrated.

(3) All dates above are meant as "not later than". However, Members and Organizations are encouraged to start experimental exchange, and, if all relevant conditions (see below) are satisfied, to start operational exchange as soon as possible.

Added Note:

(4) May be used for national purposes or by bilateral agreement; will no longer be maintained by WMO as an active code.

- Start of experimental exchange: data will be made available in BUFR (CREX) but not operationally, i.e. in addition to the current alphanumeric codes, which are still operational.

- Start of operational exchange: data will be made available in BUFR (CREX) whereby some (but not all) Members rely on them operationally. Still the current alphanumeric codes will be distributed (parallel distribution).

- Migration complete: at this date the BUFR (CREX) exchange becomes the standard WMO practice. Parallel distribution is terminated. For archiving purposes and at places where BUFR (CREX) exchange still causes problems the alphanumeric codes may be used on a local basis only.

Relevant conditions to be satisfied before experimental exchange may start:

- Corresponding BUFR/CREX-tables and templates are available;
- Training of concerned testing parties has been completed;
- Required software of testing parties (encoding, decoding, viewing) is implemented;

Relevant conditions to be satisfied before operational exchange may start:

- Corresponding BUFR/CREX-tables and templates are fully validated;
- Training of all concerned parties has been completed;
- All required software (encoding, decoding, viewing) is operational.

ANNEX TO PARAGRAPH 6.6.1

CODING OF SQUALL LINES IN WEST AFRICA IN CREX

1. West African Track and Trajectory CREX Code (WATTCC) type 1

For squall lines observations (3 points) and forecasted trajectory and evolution:

CREX++
T00020412// A007001 P00012000 U00 S001 Y20050823 H1830 D16060++
2005 08 23 17 50 1500 –01000 070 00010 1900 –00840 1100 –01220 02 0038 0300++
7777

T00020412// = 00 = Master table for meteorology
02 = CREX edition number
04 = BUFR edition number
12 = version table of BUFR/CREX
// = No local table

A007001 = 007 = Synoptic features
001 = Squall Line

P00012000 = 00012 = Originating Centre = Dakar
000 = No sub-centre

U00 = 00 = Sequence number of message, = *0 = first*

S001 = 001 = number of sub-sets in the report = 1

Y20050823 = Date of the message = year, month, day
H1830 = Hour of the message = hour, minute

D16060	**Common sequence defining Squall line (type 1)**
	Time of observation:
	D01011 Date:
2005	= Year
08	= Month
23	= Day
	D01012 Hour:
17	= Hour
50	= Minute
	Position of Squall Line Centre:
	B05002 Latitude:
1500 =	15 deg. North
	B06002 Longitude:
-01000 =	10 deg. West
	B19005 Direction of moving feature:
070 =	070 degrees
	B19006 Speed of moving feature:
00010 =	10 m/s

Amplitude of feature, from most external point to centre point:

	North side:
	B05002 Latitude:
1900 =	19 deg. North
	B06002 Longitude:
-00840 =	8 deg. 40 West
	South side:
	B05002 Latitude:
1100 =	11 deg. North
	B06002 Longitude:
-01220 =	12 deg. 20 West
	B20028 Evolution of feature:
02 =	Intensification
	B11041 maximum burst expected:
0038 =	38 m/s
	B13055 intensity of rain expected:
0300 =	300 mm/h

0 20 028

Expected change in intensity

Code figure	
0	Stability
1	Diminution
2	Intensification
3	Unknown
4-14	Reserved
15	Missing value

2. West African Track and Trajectory CREX Code (WATTCC) type 2

For squall lines (defined with more than 3 points) observations and forecasted trajectory and evolution:

CREX++
T00020412// A007001 P00012000 U00 S001 Y20050823 H1830 D16061++
2005 08 23 17 50 1500 –01000 070 00010 0002 1900 –00840 1700 –00940 0001 1100 –01220 02 0038 0300++
7777

T00020412// =	00 = Master table for meteorology
	02 = CREX edition number
	04 = BUFR edition number
	12 = version table of BUFR/CREX
	// = No local table
A007001 =	007 = Synoptic features
	001 = Squall Line
P00012000 =	00012 = Originating Centre = Dakar
	000 = No sub-centre
U00 =	00 = Sequence number of message, = *0* = *first*
S001 =	001 = number of sub-sets in the report = 1
Y20050823 =	Date of the message = year, month, day
H1830 =	Hour of the message = hour, minute
D16061	**Common sequence defining Squall line (type 2)**
	Time of observation:
	D01011 Date:
2005	= Year
08	= Month
23	= Day
	D01012 Hour:
17	= Hour
50	= Minute
	Position of Centre:
	B05002 Latitude:
1500 =	15 deg. North
	B06002 Longitude:
-01000 =	10 deg. West
	B19005 Direction of moving feature:
070 =	070 degrees
	B19006 Speed of moving feature:
00010 =	10 m/s

Amplitude of feature, from most external point to centre point:

	North side:
	R02000 define replication of next 2 descriptors:
0002 =	twice *(for 2 points)*
	First point:
	B05002 Latitude:
1900 =	19 deg. North
	B06002 Longitude:
-00840 =	8 deg. 40 West
	Second point:
	B05002 Latitude:
1700 =	17 deg. North
	B06002 Longitude:
-00940 =	9 deg. 40 West
	South side:
	R02000 define replication of next 2 descriptors:
0001 =	no replication *(1 point only)*
	B05002 Latitude:
1100 =	11 deg. North
	B06002 Longitude:
-01220 =	12 deg. 20 West
	B20028 Evolution of feature:
02 =	Intensification
	B11041 maximum burst expected:
0038 =	38 m/s
	B13055 intensity of rain expected:
0300 =	300 mm/h

ANNEX TO PARAGRAPH 6.6.2

QUESTIONS AFTER TYING ENCODING OF SYNOP IN CREX AT EAMAC (NIAMEY)

Examples of coding in CREX are missing.

There are about 9 different examples available from the Training Seminars (coupled with original SYNOP messages and detailed explanations) plus additional 4 CREX messages which the participants were asked to create (with the solutions available).

What code tables are for CREX (it is not clear?)

It has been always pointed out that CREX B Tables do not exit in a separate form, but that they are included in BUFR Table B. If used for CREX, "0" is to be replaced by "B", in the descriptor name. Code Tables for BUFR are the same for CREX. Supplementary values for CREX, if any, will be "not used". Flag Tables are also the same but are coded in octal in CREX, with leading zeros if needed.

Present and Past Weather: why coded with 3 and 2 figures?

Code Table for Present weather accommodates not only code figures for present weather observed at a manned station, but also code figures for present weather from automatic station.

Rain coded with //// or 0000? How to indicate traces?

Total precipitation has data width 5, not 4. Precipitation ///// means that measurement was not done. Precipitation 00000 indicates "no precipitation". Trace is reported as negative value -1.

What about CAVOK, SKC, NSC and NSW of METAR, AND TAF in CREX? If coded still, how?

If reported in CREX, which is hardly to be expected, these entries would be reported using code table B 20 009.

Nebulosity: how to convert in %?

Sky clear………….0%,
1/8………………...13%,
2/8……………..….25%,
……………….
8/8……………..……100%,
sky obscured by
meteorological
phenomena ……113%.

ANNEX TO PARAGRAPH 6.6.3.1

Proposed migration timeframe for Tanzania Meteorological Agency:

PROPOSED MIGRATION TIMEFRAME FOR TMA

	Item \ Time	2003	2004	2005	2006	2007	2008
1	Preparatory meeting						
2	Training Level 1 management.						
3	Initiate request for funding						
4	Training Level 1 All data producers						
5	Acquisition of CREX/BUFR decoders						
6	Training Level 2 Outside Tanzania						
7	Training Levels 3						
8	Start of experimental exchange						

ANNEX TO PARAGRAPH 6.6.3.2

CREX template for SYNOP data from RA I

		Surface station identification, time, horizontal and vertical coordinates		**in CREX**
D 01 004	B 01 001	WMO block number	**II**	Numeric, 0, 2
	B 01 002	WMO station number	**iii**	Numeric, 0, 3
	B 01 015	Station or site name		Character, 0, 20
	B 02 001	Type of station	**(i_x)**	Code table, 0, 1
D 01 011	B 04 001	Year		Year, 0, 4
	B 04 002	Month		Month, 0, 2
	B 04 003	Day	**YY**	Day, 0, 2
D 01 012	B 04 004	Hour	**GG**	Hour, 0, 2
	B 04 005	Minute	**gg**	Minute, 0, 2
D 01 021	B 05 001	Latitude (high accuracy)		Degree, 5, 7
	B 06 001	Longitude (high accuracy)		Degree, 5, 8
B 07 030		Height of station ground above msl		m, 1, 6
B 07 031		Height of barometer above msl		m, 1, 6
		Pressure data		
D 02 001	B 10 004	Pressure	**$P_oP_oP_oP_o$**	Pa, –1, 5
	B 10 051	Pressure reduced to mean sea level	**PPPP**	Pa, –1, 5
	B 10 061	3-hour pressure change	**ppp**	Pa, –1, 4
	B 10 063	Characteristic of pressure tendency	**a**	Code table, 0, 2
B 10 062		24-hour pressure change	**$p_{24}p_{24}p_{24}$**	Pa, –1, 4
B 07 004		Pressure (standard level) = 925, 850, 700, ..hPa = missing for lowland stations	**a_3**	Pa, –1, 5
B 10 009		Geopotential height of the standard level = missing for lowland stations	**hhh**	gpm, 0, 5
		Temperature and humidity		
B 07 032		Height of sensor above local ground (for temperature measurement)		m, 2, 5
B 12 101		Temperature/dry-bulb temperature (sc. 2)	**s_nTTT**	°C, 2, 4
B 12 103		Dew-point temperature (sc. 2)	**$s_nT_dT_dT_d$**	°C, 2, 4
B 13 003		Relative humidity		%, 0, 3
B 07 032		Height of sensor above local ground (set to missing to cancel the previous value)		m, 2, 5
		Visibility		
B 20 001		Horizontal visibility	**VV**	m, –1, 4
		Cloud data		
D 02 004	B 20 010	Cloud cover (total) If N = 9, then B 20 010 = 113 %, if N = /, then B 20 010 = missing.	**N**	%, 0, 3
	B 08 002	Vertical significance if C_L are observed, then B 08 002 = 7 (low cloud), if C_L are not observed and C_M are observed, then B 08 002 = 8 (middle cloud), if only C_H are observed, B 08 002 = 0, if N = 9, then B 08 002 = 5, if N = 0, then B 08 002 = 62, if N = /, then B 08 002 = missing.		Code table, 0, 2
	B 20 011	Cloud amount (of low or middle clouds) If N = 0, then B 20 011 = 0, if N = 9, then B 20 011 = 9,	**N_h**	Code table, 0, 2

		if N = /, then B 20 011 = missing.	
	B 20 013	Height of base of cloud **h** If N = 0 or /, then B 20 013 = missing.	m, –1, 4
	B 20 012	Cloud type (low clouds) **C_L** B 20 012 = C_L + 30, if N = 0, then B 20 012 = 30, if N = 9 or /, then B 20 012 = 62.	Code table, 0, 2
	B 20 012	Cloud type (middle clouds) **C_M** B 20 012 = C_M + 20, if N = 0, then B 20 012 = 20, if N = 9 or / or C_M = /, then B 20 012 = 61.	Code table, 0, 2
	B 20 012	Cloud type (high clouds) **C_H** 0 20 012 = C_H + 10, if N = 0, then B 20 012 = 10, if N = 9 or / or C_H = /, then B 20 012 = 60.	Code table, 0, 2
R 01 000		Delayed replication of the next 1 descriptor	
D 02 005	B 08 002	Vertical significance In any Cb layer, B 08 002 = 4 , else: in the first replication: if N = 9, then B 08 002 = 5, if N = /, then B 08 002 = missing, else B 08 002 = 1; in the other replications B 08 002 = 2, 3, 4**.**	Code table, 0, 2
	B 20 011	Cloud amount **N_s** In the first replication: If N = /, then B 20 011 = missing, else B 20 011 = **N_s**; in the other replications B 20 011 = **N_s**.	Code table, 0, 2
	B 20 012	Cloud type **C** if N = 9 or /, then B 20 012 = missing, else B 20 012 = **C**.	Code table, 0, 2
	B 20 013	Height of base of cloud **h_sh_s**	m, -1, 4
		Present and past weather	
B 20 003		Present weather **ww**	Code table, 0, 3
B 04 024		Time period At 00, 06, 12, 18 UTC **= - 6.** At 03, 09,15, 21 UTC **= - 3.**	Hour, 0, 4
B 20 004		Past weather (1) **W_1**	Code table, 0, 2
B 20 005		Past weather (2) **W_2**	Code table, 0, 2
		Evaporation	
B 04 024		Time period in hours **= - 24**	Hour, 0, 4
B 02 004		Type of instrument for evaporation or crop type for evapotranspiration **i_E**	Code table, 0, 2
B 13 033		Evaporation /evapotranspiration **EEE**	kg m^{-2}, 1, 4
		Sunshine	
R 02 002		Replicate next 2 descriptors 2 times	
B 04 024		Time period in hours In the first replication **= - 24,** in the second replication **= - 1.**	Hour, 0, 4
B 14 031		Total sunshine in minutes In the first replication **SSS** in the second replication **SS**	Minute, 0, 4
		Precipitation	
R 02 002		Replicate next 2 descriptors 2 times	

B 04 024		Time period in hours **t_R**	Hour, 0, 4
B 13 011		Total precipitation **RRR** no precipitation = 0 trace = - 0.1	kg m^{-2}, 1, 5 Encoded as: -00001
		Extreme temperatures	
B 07 032		Height of sensor above local ground (for temperature measurement)	m, 2, 5
B 04 024		Time period in hours **= - 12**	Hour, 0, 4
B 12 111		Maximum temperature at height and over period specified **$s_nT_xT_xT_x$**	°C, 2, 4
B 04 024		Time period in hours **= - 12**	Hour, 0, 4
B 12 112		Minimum temperature at height and over period specified **$s_nT_nT_nT_n$**	°C, 2, 4
		Wind data	
B 07 032		Height of sensor above local ground (for wind measurement)	m, 2, 5
B 02 002		Type for instrumentation for wind measurement **i_w**	Flag table, 0, 2
B 08 021		Time significance **= 2** (time averaged)	Code table, 0, 2
B 04 025		Time period **= - 10** (or number of minutes after a significant change of wind, if any)	Minute, 0, 4
B 11 001		Wind direction **dd** If dd = 00 (calm) or dd = 99 (variable), B 11 001 = 0.	Degree true, 0, 3
B 11 002		Wind speed **ff**	m s^{-1}, 1, 4
B 08 021		Time significance (set to **missing** to cancel the previous value)	Code table, 0, 2

TANZANIA METEOROLOGICAL AGENCY

Form No. [illegible]

REGISTER OF METEOROLOGICAL OBSERVATIONS Day… [illegible] Date… 22 Month… February Year… 2006

CREX++

T000103 A000 D01050 D02031 D02032 D02033 D02034 [illegible]

[illegible] ++

Entry No.	[illegible]	[illegible]	[illegible]	Element name	Symbolic letter	Unit	Scale	Data width	0000 Raw Data	0000 CREX Data	0300 Raw Data	0300 CREX Data	0600 Raw Data	0600 CREX Data	0900 Raw Data	0900 CREX Data
				Identification												
1	D 01 050	D 01 004	B 01 001	WMO Block Number	II	Numeric	0	2					63	63		
2			B 01 002	WMO Station Number	iii	Numeric	0	3					894	894		
3			B 01 015	Station or site name		Character	0	20					DAR	DAR		
4			B 02 001	Type of station	i_x	Code table	0	1					MANNED	1		
5		D 01 011	B 04 001	Year		Year	0	4					2006	2006		
6			B 04 002	Month		Month	0	2					FEB	02		
7			B 04 003	Day	YY	Day	0	2					22	22		
8		D 01 012	B 04 004	Hour	GG	Hour	0	2					0600	06		
9			B 04 005	Minute	gg	Minute	0	2					0000	00		
10		D 01 023	B 05 002	Latitude (coarse accuracy)	$L_aL_aL_a$	Degree	2	4					6°52'S	0687		
11			B 06 002	Longitude (coarse accuracy)	$L_oL_oL_oL_o$	Degree	2	5					39°12'E	03920		
12		B 07 030		Height of station ground above mean sea level		m	1	5					55.2m	000552		
13		B 07 031		Height of barometer above mean sea level		m	1	5					56.4m	00564		
				Pressure data												
14	D 02 031	D 02 001	B 10 004	Pressure	$P_0P_0P_0P_0$	Pa	-1	5					100620	10062		
15			B 10 051	Pressure reduced to mean sea level	PPPP	Pa	-1	5					101220	10122		
16			B 10 061	3-hour pressure change	ppp	Pa	-1	4					Missing	///		
17			B 10 063	Characteristic of pressure tendency	a	Code table	0	2					Missing	/		
18		B 10 062		24-hour pressure change	$P_{24}P_{24}P_{24}P_{24}$	Pa	-1	4					00	0000		
19		B 07 004		Pressure (standard level)	a_3	Pa	-1	5					Missing	///		
20		B 10 009		Geopotential height of the standard level	hhh	gpm	0	5					Missing	///		
				Temperature and Humidity												
21	D 02 032	B 07 032		Height of sensor above local ground		m	2	5					1.25m	00125		
22		B 12 101		Temperature/dry-bulb temperature	TTT	°C	2	4					25.0°C	2500		
23		B 12 103		Dew-point temperature	$T_dT_dT_d$	°C	2	4					21.2°C	2120		
24		B 13 003		Relative humidity		%	0	3					71%	071		
				Visibility												
25	D 02 033	B 07 032		Height of sensor above local ground		m	2	5					1.60m	00160		
26		B 20 001		Horizontal visibility	VV	m	-1	4					25000	2500		
				Clouds												
27	D 02 004	D 02 004	B 20 010	Cloud cover (total)	N	%	0	3					38%	038		
28			B 08 002	Vertical significance		Code table	0	2					7	07		
29			B 20 011	Cloud amount (of low or middle clouds)	N_h	Code table	0	2					3 Oktas	03		
30			B 20 013	Height of base of clouds	h	m	-1	4					730m	0073		
31			B 20 012	Cloud type (low clouds)	C_L	Code table	0	2					1	31		
32			B 20 012	Cloud type (middle Clouds)	C_M	Code table	0	2					0	20		
33			B 20 012	Cloud type (high clouds)	C_H	Code table	0	2					0	10		

34	R 01 000	R 01 000		Delayed replication of the next 1 descriptor				4					1	0001		
35	D 02 005	D 02 006	B 08 002	Vertical significance		Code table	0	2					7	07		
36			B 20 011	Cloud amount	N_h	Code table	0	2					3	03		
37			B 20 012	Cloud type;	C	Code table	0	2					8	08		
38			B 20 013	Height of base of cloud	h_sh_s	m	-1	4					730m	73		
39		D 02 006	B 08 002	Vertical significance		Code table	0	2								
40			B 20 011	Cloud amount	N_h	Code table	0	2								
41			B 20 012	Cloud type;	C	Code table	0	2								
42			B 20 013	Height of base of cloud	h_sh_s	m	-1	4								
43		D 02 006	B 08 002	Vertical significance		Code table	0	2								
44			B 20 011	Cloud amount;	N_h	Code table	0	2								
45			B 20 012	Cloud type;	C	Code table	0	2								
46			B 20 013	Height of base of cloud	h_sh_s	m	-1	4								
47		D 02 006	B 08 002	Vertical significance		Code table	0	2								
48			B 20 011	Cloud amount	N_h	Code table	0	2								
49			B 20 012	Cloud type;	C	Code table	0	2								
50			B 20 013	Height of base of cloud	h_sh_s	m	-1	4								
				Present and past weather												
51	D 02 010	B 20 003		Present weather	ww	Code table	0	3					05	005		
52		B 04 024		Time period or displacement		Hour	0	4					-6	-0006		
53		B 20 004		Past weather (1)	W_1	Code table	0	2					0	00		
54		B 20 005		Past weather (2)	W_2	Code table	0	2					0	00		
				Evaporation												
55	D 02 044	B 04 024		Time period or displacement		Hour	0	4					-24	-0024		
56		B 02 004		Type of instrumentation for evapo	i_E	Code table	0	2					1	01		
57		B 13 033		Evaporation/evapotranspiration	EEE	kgm^{-2}	1	4					3.5kgm^{-2}	0035		
				Sunshine												
58	R 01 002 D 02 035	R 02 002		Replicate next 2 descriptors 2 times												
59		B 04 024		Time period or displacement		Hour	0	4					-24	-0024		
60		B 14 031		Total sunshine in minutes (1st replication)	SSS	Minute	0	4					330	0330		
61		B 04 024		Time period or displacement		Hour	0	4					1	-0001		
62		B 14 031		Total sunshine in minutes (2nd replication)	SS	Minute	0	4					60	0060		
				Precipitation												
63	R 02 002	R 02 002		Replicate next 2 descriptors 2 times												
64	B 04 024	B 04 024		Time period or displacement	t_R	Hour	0	4					-24	-0024		
65	B 13 011	B 13 011		Total precipitation:	RRR	kgm^{-2}	1	5					0	0000		
66		B 04 024		Time period or displacement	t_R	Hour	0	4					Missing	///		
67		B 13 011		Total precipitation:	RRR	kgm^{-2}	1	5					Missing	///		
				Extreme temperatures												
68	B 07 032	B 07 032		Height of sensor above local ground		m	2	5					1.25m	00125		
69	B 04 024	B 04 024		Time period or displacement		Hour	0	4					Missing	///		
70	B 12 111	B 12 111		Maximum temperature	$T_xT_xT_x$	°C	2	4					Missing	///		
71	B 04 024	B 04 024		Time period or displacement		Hour	0	4					-12	-0012		
72	B 12 112	B 12 112		Minimum temperature	$T_nT_nT_n$	°C	2	4					22.1°C	2210		
				Wind data												
73	B 07 032	B 07 032		Height of sensor above local ground		m	2	5					10m	01000		
74	B 02 002	B 02 002		Type of instrumentation for wind measurement	i_w	Flag table	0	2					14	14		
75	B 08 021	B 08 021		Time significance		Code table	0	2					2	2		
76	B 04 025	B 04 025		Time period or displacement		Minute	0	4					-10	-0010		
77	B 11001	B 11001		Wind direction;	dd	Degree true	0	3					100	100		
78	B 11 002	B 11 002		Wind speed	ff	ms^{-1}	1	4					2.5ms^{-1}	00025		
79	B 08 021	B 08 021		Time significance		Code table	0	2					Missing	/		
80				Section Terminator						++		++		++		++
81				End Section						7777		7777		7777		7777
82				Observer's initials									GJ			

TEST CREX MESSAGE

CREX++

T000103 A000 D01090 D02031 D02032 D02033 D02004 R01000 D02005 D02038 D02044 R01002 D02039 R02002 BO4024 B13011 B07032 B04024 B12111 B04024 B12112 B07032 B02002 B08021 B04025 B11001 B11002 B08021++
63 894 DAR-ES-SALAAM 1 2006 02 22 06 00 -0687 03920 00552 00564 10062 10122 //// // 0000 ///// ///// 00125 2900 2320 071 00168 2500 038 07 03 0073 31 20 10 0001 07 03 08 0073 005 -0006 00 00 -0024 01 0085 -0024 0690 -0001 0060 -0024 00000 //// //// 00125 //// //// -0012 2210 0100 14 02 -0010 060 0025 // ++
7777

ANNEX TO PARAGRAPH 7.2.2.2

Third International PMO workshop, Hamburg, Germany, 23-24 March 2006

Annex VIII

\Recommendations on migration from SHIP to BUFR code form issue:

1) Frits Koek (KNMI) and Sarah North (UK Met Office) undertook to review the required data and metadata elements that would be required in a VOS and VOSClim BUFR template. The resulting listing would then be submitted to a new informal ad hoc task team on SOT migration to BUFR (Frits Koek, Sarah North, Pierre Blouch, Graeme Ball, Julie Fletcher, Etienne Charpentier) by 1 June 2006. Comments submitted by the team by 1 July 2006.
2) WMO will liaise with CBS ET/DRC and CT/MTDCF and advise that the SOT is working on revisiting the list of element for inclusion in the VOS BUFR template for ship data and is seeking ET/DRC help.
3) The SOT and ET/DRC will liaise to develop a draft BUFR template suitable for VOS and VOSClim, which will be submitted for endorsement by SOT-IV.

The meeting considered a possible implementation scenario as follows:

(i) Phase 1, target 2007: Member Countries to work on software that converts SHIP to BUFR (1 to 1 conversion) and implement it on a case by case basis.
(ii) Phase 2, target 2006 to SOT-IV: analyse requirements and consider possible solutions (e.g. (proprietary format + metadata) to BUFR, or ("SOT" format + metadata) to BUFR. "SOT" format is a format inspired from FM-13 SHIP format and can be regarded as proprietary; it is not intended for direct GTS distribution but as a practical way of using existing software slightly modified to achieve BUFR distribution of the data on the GTS.
(iii) Phase 3, target 2008: Implementation of proposed recommendations.
(iv) Phase 4, target 2012: Operational system in place.

ANNEX TO PARAGRAPH 7.4.2

Some of the content expected in the Migration Guidance Document:

– The automation is needed not at stations level at the start; NMCs can convert into BUFR after the national concentration.

- Manual coding in CREX can also be an intermediate solution if there is a real immediate need to transmit additional parameters, new data types or necessary metadata. *(This must be clearly explained).*

- To satisfy new requirement for obtaining in real time all levels of sounding data as soon as available, explain how to translate TEMP in BUFR. Parts A and B of the current TEMP message are sent as soon as available, with a specific GTS header for each part. Some numerical models use only these parts A and B in their data assimilation scheme. Thus, it is not possible to start the forecast with a shorter cut-off time. When the equivalent messages in BUFR will be exchanged, such a piece-by-piece message transmission does not seem possible. This will diminish the quantity of information available to the model, or force users to wait longer to obtain the last numerical forecast of equivalent quality. It was reported that this problem had been considered at CBS XIII and a solution proposed. It was written in the CBS report in ANNEX III, paragraph 3.2, G3 that:

> "In the interest of timely data delivery, the first BUFR (or CREX) message should be sent when level 100 hPa is reached and the second message should be sent when the whole sounding is completed (containing all observation points). The delivery of the profile data in several stages may be necessary to accommodate the interests of other application areas, such as nowcasting and aeronautical meteorology. Collaboration with CIMO and various code groups should be established."

(Guidance for conversion of TEMP to BUFR should be very clear)

- Explain the process and steps to be followed when producers are ready. They have to go through some verification tests. It is fundamental to verify the data, especially if there is no dual transmission for these data. For the checking of encoded data, it is recommended to perform fully nationally the decoding first and then when it is satisfying perform experimental bilateral exchange(s). (*The bi-lateral exchange for testing could be organized in each region, or some Centres could also volunteer to check other NMCs, what ever their location: please the meeting should make a list of these centres.*)

- Of immediate importance was providing to WMO members the procedures, which should be followed to begin exchange of their migrated data. The procedures to start the dissemination of new BUFR bulletins should be clearly explained in the guidance. These procedures are not new. They are already defined and are the standard procedures for implementation of new bulletins on the GTS. It is not understood by all members that there are no new or unique procedures (see below)

Procedures for notifying WWW centres of the insertion of new bulletins into the GTS such as BUFR/CREX bulletins within the framework of the migration to TDCF

1. The procedures for notifying WWW centres and the Secretariat of the insertion of new BUFR bulletins inserted into the GTS within the framework of the migration to TDCF are given hereunder. The procedures are those for notifying any new GTS bulletins.

2. Each WWW centre is in the zone of responsibility of an RTH, which is associated to an MTN centre (see http://www.wmo.int/web/www/ois/Operational_Information/VolumeC1/RTHs/zoneofresponsibility.html). There are two cases:

   a. The MTN centre 4 is maintaining the part of Volume C1 - Catalogue of Meteorological Bulletins – corresponding to the bulletins issued from the zone for which it is responsible for the collection, exchange and distribution of data and/or share this responsibility with the RTHs (not on the MTN) included in its zone of responsibility through regional arrangements (see paragraph 1.4.1 of Part I of Volume I of the Manual on the GTS). ***In accordance with these arrangements, the WWW centre should send advanced notifications of the insertion of new bulletins to its associated RTH or MTN centre.*** The RTH or MTN centres are responsible for compiling the advanced notifications and to send them to the WMO Secretariat. In this respect, CBS-Ext.(1998) agreed on procedures to exchange advanced notifications, in particular to post the advanced notifications into the WMO FTP server (see http://www.wmo.int/web/www/ois/Operational_Information/VolumeC1/ReportsFromMeetings/CBS-Ext98AnnexIII.pdf).

   b. When such arrangements have not yet been defined, the WWW centre should send the advanced notifications to the Secretariat.

3. Advanced notifications shall be sent to the Secretariat at least two months in advance of the effective date of the change (see paragraph 5.1 of Part II of Volume I of the Manual on the GTS).

4. The Secretariat inserts into the GTS METNO messages including the last advanced notifications. The Secretariat maintains a comprehensive Volume C1 (see http://www.wmo.int/web/www/ois/Operational_Information/VolumeC1/VolC1.html) on the basis of the advanced notifications and the updated parts of Volume C1 received from the MTN centres every six months. An interactive access to Volume C1 is available from http://alto-stratus.wmo.ch/WWWOIS/.

5. For any further information on the maintenance of Volume C1, WWW centres should send e-mails to JBest@wmo.int

4 13 MTN centres (Algiers, Beijing, Brasilia, Buenos Aires, Cairo, Exeter, Melbourne, Moscow, Offenbach, Prague, Sofia, Tokyo and Toulouse) were using the database procedures for maintaining their own parts of Volume C1.

ANNEX LIST OF ACRONYMS

ACARS	AirCraft Addressing and Reporting System
ADS	Astrophysics Data System (USA)
AFWA	Air Force Weather Agency (USA)
AIRS	Advanced Infra-Red Sounder
AMDAR	Aircraft Meteorological Data Relay
AMS	American Meteorological Society
AMSU	Advanced Microwave Sounding Unit
ANC	Air Navigation Commission (ICAO)
ANSI	American National Standards Institute
API	Application Program Interface
APSDEU	Asia Pacific Satellite Data Exchange and Utilization
ASCAT	Advanced SCATterometer
ATOVS	Advanced TIROS Operational Vertical Sounder
AWIPS	Advanced Weather Interactive Processing System
AWC	Aviation Weather Center
AWS	Automatic Weather Station
ATSR	Along Tack Scanning Radiometer
BUFR	Binary Universal Form for data Representation
CAeM	Commission for Aeronautical Meteorology
CBS	Commission for Basic Systems
CBS-Ext.(98)	Extraordinary session of CBS held in 1998
CCI	Commission for Climatology (WMO)
CGMS	Coordination Group for Meteorological Satellites
CIMO	Commission for Instruments and Methods of Observations
CLM	CLoud Mask (EUMETSAT)
CLAI	CLoud Analysis Image (EUMETSAT)
CMA	China Meteorological Administration
COST	European Co-Operation in the field of Scientific and Technical research
CREX	Character Representation form for data EXchange
CRM	Clear sky Reflectance Map (EUMETSAT)
CSV	Comma-Separated Value (format)
CT	Coordination Team
CTH	Cloud Top Height (EUMETSAT)
DBCP	Drifting Buoy Cooperation Panel
DBMS	Data Base Management System
DCP	Data Collection Platform
DIF	Directory Interchange Format
DOD	Department Of Defence (USA)
DPFS	Data Processing and Forecasting Systems
DRT	Data Representation Template
DT	Data Template
DWD	Deutscher Wetter Dienst
EANPG	European Air Navigation Planning Group
EARS	EUMETSAT ATOVS Retransmission Service
EC	Executive Council of the WMO
ECMWF	European Centre for Medium-range Weather Forecast
EGOWS	European Group on Operational Worskstation Systems
EOS	Earth Observation Science
EP	Ensemble Prediction
EPA	Environmental Protection Agency (USA)
EPS	Ensemble Prediction System
ESA	European Space Agency
ESCAP	*United Nations* Economic and Social Commission for Asia and the Pacific
ET	Expert Team
ET/EDF	Expert Team on Evolution of Data Formats

ET/DR&C	Expert Team on Data Representation and Codes
EUMETNET	European Meteorological Networks
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
FAA	Federal Aviation Administration (USA)
FIR	FIRe Detection Product (EUMETSAT)
FIR	Flight Information Region
FNMOC	Fleet Numerical Meteorology and Oceanography Centre
FORTRAN	FORmula TRANslation
FTP	File Transfer Protocol
FWIS	Future WMO Information System
GDPS	Global Data Processing System
GDT	Grid Definition Template
GEMS	Global and regional Earth-system Monitoring using Satellite and in situ data
GEO	Group on Earth Observation
GHRSST	GODAE High Resolution SST (Pilot Project)
GIF	Graphic Interchange Format
GIS	Geographic Information System
GMES	Global Monitoring for the Environment and Security
GODAE	Global Ocean Data Assimilation Experiment
GOS	Global Observing System
GRAS	Global RAdio occultation Sounder
GRIB 1	Processed data in the form of GRId-point values expressed in Binary form - GRIB Edition 1
GRIB 2	General Regularly distributed Information in Binary form - GRIB Edition 2
GTS	Global Telecommunications System
HIRS	HIgh Resolution infrared Sounder
HMEI	HydroMeteorology Equipment Industry
HTML	Hyper Text Markup Language
IASI	Infrared Atmospheric Sounding Interferometer
ICAO	International Civil Aviation Organisation
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	Implementation/Coordination Team (of CBS)
ICT/DRC	Implementation/Coordination Team on Data Representation and Codes
ID	Identifier
IEC	International Electrotechnical Commission
IEEE	Institution of Electrical and Electronics Engineers
IGACO	Integrated Global Atmospheric Chemistry Observation (System)
IJPS	Initial Joint Polar System
IOC	Intergovernmental Oceanographic Commission of UNESCO
ISO	International Standards Organization
ISS	Information Systems and Services (OPAG of CBS)
IUT	Indicator of Unit of Time
JAXA	Japan Aerospace eXploration Agency
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
JMBL	Joint Meteorological and Oceanographic (METOC) Broker Language (XML)
JPEG	Joint Photographic Experts Group format
LINUX	*Not an acronym – name of an operating system*
LZW	Lempel-Ziv-Welch compression
MEDS	Marine Environment Data Service
MHS	Microwave Humidity Sounder
MIP	Migration Implementation Programme
MPE	Multi sensor Precipitation Estimate (EUMETSAT)
MS/DOS	/Disk Operating System
MSG	METEOSAT Second Generation
MSS	Message Switching System

MTDCF	Migration to Table Driven Code Forms
MTN	Main Telecommunications Network (of the GTS)
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Centre (USA)
NCEP	National Centre for Environment Prediction (USA)
NetCDF	Network Common Data Form
NEDEX	North American Europe Data Exchange
NESDIS	National Environmental Satellite Data and Information Service
NMC	National Meteorological Centre
NMHS	National Meteorological or Hydrological Service
NMS	National Meteorological Service
NMTSG	National Migration to TDCF Steering Group
NOAA	National Oceanographic and Atmospheric Administration (USA)
NWP	Numerical Weather Prediction
NWS	National Weather Service (USA)
OMF	weather Observation Markup Format
OPAG	Open Programme Area Group (of CBS)
OPAG-ISS	Open Programme Area Group on Information Systems and Services
PDT	Product Definition Template
PM	Particulate Matter
PNG	Portable Network Graphic
RA	Regional Association (WMO)
RASS	Radio Acoustic Sounding System
RDBC	Regional Data Bank Centre
RSS	Radiosonde Replacement System (program) (USA)
RSMC	Regional Specialised Meteorological Centre
RTH	Regional Telecommunication Hub
SGDR&C	Sub-Group on Data Representation and Codes (CBS)
SGML	Standard Generalized Markup Language
SI	System International
SOOP	Ship Of Opportunity Programme
SOT	Ship Observation Team
SST	Sea Surface Temperature
TAC	Traditional Alphanumeric Codes
TCP	Tropical Cyclone Programme
TCP/IP	Transport Control Protocol/Internet Protocol
TDCF	Table Driven Code Form
TDL	Techniques Development Laboratory
THORPEX	The Observing system Research and Predictability EXperiment
TIFF	Tagged Image File Format
TIGGE	Thorpex Interactive Grand Global Ensemble
TIROS	Television InfraRed Observation Satellite
TMA	Tanzania Meteorological Agency
TOVS	TIROS Operational Vertical Sounder
TWS	Tsunami Warning System
UGRN	Upgrading the Global Radiosonde Network
UKMO	United Kingdom Meteorological Office
UML	Unified Modeling Language
UNEP	United Nations Environment Programme
UNIX	*Not an acronym – name of an operating system*
URL	Uniform Resource Locator
USAP	United States Antarctic Programme
UTC	Universal Time Coordinate
UVI	Ultra Violet Index
VCP	Voluntary Cooperation Programme
VGISC	Virtual Global Information System Centre
VOS	Voluntary Observing Ship

WAFC	World Area Forecasting Centre (ICAO)
WAFS	World Area Forecasting System
WGDM	Working Group on Data Management (CBS)
WGMC	Working Group on Meteorological Codes (USA)
WGS	Working Group on Standards
WH	Weather-Huffman compression
WHO	World Health Organization
WIS	WMO Information System
WMO	World Meteorological Organization
WWW	World Weather Watch
W3C	World Wide Web Consortium
XBT	eXpendable Bathy Thermograph
XCTD	eXpendable Conductivity Temperature Depth sensor
XML	eXtensible Markup Language
4-DVAR	Four Dimensional VARiational Analysis