WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

OPAG ON INFORMATION SYSTEMS AND SERVICES

MEETING OF THE EXPERT TEAM ON DATA REPRESENTATION AND CODES

FINAL REPORT

MUSCAT, OMAN, 5-8 December 2005

EXECUTIVE SUMMARY

The Meeting of the Expert Team Data Representation and Codes (ET/DR&C) was held, at the kind invitation of Oman in Muscat, from 5 to 8 December 2005.

The Team reviewed the status of validation tests for FM 92 GRIB Edition 2. Further validation tests were recommended for the templates related to the encoding/decoding of cross-sections, Hovmöller type diagrams and the Weather-Huffman compression. The Team agreed to the additions of parameters in GRIB 2 Tables, mainly for TIGGE fields, for fire detection and clear sky radiance EUMETSAT data, for UV Index field and for additional precipitation fields. The Team also defined a system of Master Table Version Number for pre-operational Tables. The EUMETSAT representative reported that EUMETSAT had decided that all image type products would be encoded in GRIB Edition 2 (GRIB2). EUMETSAT delivers products in GRIB2 format: Cloud Mask (CLM), Cloud Top Height (CTH), Cloud Analysis Image (CLAI), Clear Sky Reflectance Map (CRM), Multi Sensor Precipitation Estimate (MPE), Fire Detection Product (FIR). The Team congratulated the EUMETSAT representative for this achievement and requested other centres to advertise also their available GRIB 2 products.

The Team examined various requirements, which had been expressed for additions to BUFR/CREX Tables. New descriptors were recommended for Air Chemistry data, seeking validation before May 2006, combining requests from Canada, USA and the GEMS project. The transmission of SIGMET in BUFR would be pre-operational in May 2006. Additional Common Sequences for BUFR templates of SYNOP, SHIP, and buoys were recommended. Clarifications to some BUFR regulations were approved. Numerous additions were recommended for satellite data, especially for the new European polar orbiting satellite data. At the request of Japan, additions were recommended for reporting in BUFR tropical cyclone observations performed via satellite and Radar.

ICAO passed to the Team for consideration the proposed changes to the aeronautical codes FM 15, FM 16 and FM 51, which formed a part of draft Amendment 74 to ICAO Annex 3/ WMO Technical Regulations [C.3.1.]. The Team agreed that the proposals looked correct, however the members of the Team were asked to review the amendments and put any question to the ICAO secretariat (Mr Neil Hasley) for any required clarification or question arising. The Team understood 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. A calendar with planned dates for approval of code changes and implementation for the next 4 years was proposed.

In the context of the migration, the Team appreciated the work of Dr Eva Cervena who presented reporting practices fitted for SYNOP BUFR template. The Team agreed that more work was necessary for the other reporting practices associated to the other traditional observations. Dr Eva Cervena presented also a proposal for templates covering regional practices. The Team was impressed by the work accomplished and recommended that these templates be validated. Validation of these regional templates might be done in cooperation with the Working Groups on Planning and Implementation of WWW in RAs. Equally, a way of representing national practices in TDCF was presented by Dr Cervena. The Team agreed that it was a good example to show how this could be done, but that it was not necessary to develop these templates for all the countries and that it was the responsibilities of the country concerned. Dr Eva Cervena presented also to the Team an updated and reorganized set of templates for representation of TAC data in BUFR or CREX. The Team congratulated Dr Cervena for this excellent and meticulous work. A proposal for radiosonde template was handled to the Secretariat by Mr John Nash, Vice-President of the CIMO Commission. The Team agreed that this would be another template for high-resolution radiosonde data, to be refined between UKMO and NWS, USA, aiming at finalization in May after contact with manufacturers

The Team reviewed the proposed Code Migration Implementation Tracker developed by the Chairman of the coordination team on migration to TDCF. The team agreed a “Status” column(s) for each code type was needed which would provide an indication of how many countries had or hadn’t migrated and possibly an indication of who was producing, using or translating TDCFs (BUFR or CREX). These suggestions were being forwarded for consideration by CT/MTDCF.

William Chillambo, the representative from Tanzania, provided an update on the plans within RA1 for additional training on the use and encoding of data in CREX. He indicated that transmission of data in CREX was planned to begin in early 2006 as soon as can be arranged after the training. 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.

There was a clear need for BUFR/CREX tables being represented in more suitable format for computer usage without human intervention. Since the feasibility of representing the tables in XML had been well demonstrated by JMA, the Team recommended that the tables be represented in XML format. The CT/MTDCF reviewed the need to represent corrected, amended, delayed and NIL reports. The Team recommended that NIL report should be represented by setting all the values in the BUFR subset to "missing value" except for the identification of the station and delayed replications. In general the ICAO was using non-standard units in the METAR/SPECI and TAF codes. The Team agreed that the BUFR system should be applications oriented and favour the spread of its use. Considering the importance for aviation applications, the Team agreed to allow use of non-standard units as such, provided they were defined in Common Table C-6.

The Team thanked Stanley Kellet from UKMO for producing a synthetic document on the potential use of XML in meteorology. The Team stressed again that there was a misconception on XML, carried out by some people in the meteorological community; XML was not ready to transmit everything in meteorology. To clarify, the Team stressed that XML was only a wrapper to exchange information. XML was a standard for exchanging data oriented towards displaying on computer screen, but was not a standard for representing physically the meteorological parameters. There was no existing standard, within XML, defining the physical format of the meteorological data to be exchanged. BUFR/CREX/GRIB, which were physical formats, included that feature. For XML, these standards had to be worked out. XML was self-defining, using tags, which described what the data being exchanged were. However, in order that everybody exchanged the same information, one had to describe the physical format of the data with the same agreed tags, which could be recorded in a schema (the equivalent of the BUFR/CREX tables in a certain way). The Team agreed that XML would allow WMO exchanged data to be more accessible to the wider world community. However, it was certainly not to replace BUFR, which was the most efficient code to exchange the daily 1.5 gigabytes of meteorological observation data between National Meteorological Centres in real time world wide for real time meteorological operational applications. XML would be the answer to the need of some countries to disseminate information with outside users (or for national collection of data or for limited exchange of data between countries). Only for small amount of data, it was feasible to use XML wrapper. The Team agreed that it was the role of WMO to define the XML meteorological standard, in order to keep the control of data exchange. However the present ET/DR&C Team had not the expertise to do such work and there was a need to involve the service of a consultant, who should have knowledge of XML as well as of meteorological BUFR/CREX standards. The Team also recommended to carry out a survey towards all WMO Members on the use of XML in the meteorological community, and reiterated strongly the need to organize a workshop where ideas and search for a common approach to defining an XML meteorological schema could emerge.

As for XML, NetCDF was also an envelope to exchange scientific data. It was also self-describing, 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, if not, it would still be anarchy. Thus, there was the example of the development of a Climate and Forecast (CF) convention for NetCDF by some universities, laboratory and various agencies. The WMO Code Groups had been tackling with that problem of standard definition of physical parameter representation for several decades and had achieved the task with the existing agreed Tables for BUFR, CREX and GRIB. Because people did not want to follow the WMO GRIB/BUFR/CREX standards (they could not or did not want to learn), the ET/DRC TOR was tasked to help them in a way and to develop guidance and practices for the meteorological information representation based on NetCDF (and XML). The Team 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. It had unlimited size and could be compressed, but for observations BUFR was still better. The Team acknowledged its lack of expertise in the field and recommended to hire a consultant to establish the exact requirements, how to link it with BUFR/CREX Table B and GRIB, (make inventory of possible conventions to be used, check what was in the conventions), identify what had to be done. The consultant should have expertise in NetCDF as well as good knowledge of GRIB 2 and BUFR.

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REPORT OF THE MEETING OF EXPERT TEAM ON DATA REPRESENTATION AND CODES
(Muscat, 5-8 December 2005)

1. ORGANIZATION OF THE MEETING

1.1 OPENING OF THE MEETING

1.1.1 At the kind invitation of the Sultanate of Oman, the Meeting of the Expert Team on Data Representation and Codes (ET/DR&C) took place in the Muscat Qurum Beach Ramada from 5 to 8 December 2005 (the participants' list can be found in the Annex to this paragraph). The Meeting was opened on Monday 5 December 2005 at 9 a.m. by Mr Abdul Rahim Bin Salem Ali Al Harmi, Acting Director General of Civil Aviation and Meteorology, representing the Permanent Representative of Oman with WMO. He welcomed the Experts and recalled the importance of data representation for exchange of information between countries for observations as well as products.

1.1.2 The representative of the WMO Secretariat thanked the Sultanate of Oman for the excellent hospitality. He also thanked the local organisers: Mr Badar Alrumhi and Mr Fawzi Albusaidy, and also the Director of the Department of Meteorology, Dr Ahmed Al Harthi, who worked hard, with their staff to plan and organize this meeting. He stressed that 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 on data representation and codes would have challenging tasks on the agenda for this week. Among many, they had to agree on parameter definitions for new satellite data and also for air chemistry. The templates for transmission in table driven codes of traditional alphanumeric code data needed to be adjusted. And also the team had to consider how other standards widely used could be adapted to WMO. For that the team would have to develop guidance and practices for the meteorological information representation based on XML and on NetCDF. Of course, there were always the ongoing requirements for maintaining the aeronautical codes and implementation of changes to aviation codes would have to be strongly coordinated between ICAO and WMO as requested by the Commission for Basic Systems (CBS).

1.1.3 Mr Milan Dragosavac from ECMWF, Chairman of the Team, after having thanked Oman for hosting the meeting, welcomed the participants. He then led the Team with diplomacy and efficiency.

1.2 APPROVAL OF THE AGENDA

The Team 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 Team found that unfortunately 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, and the team encouraged some centres to undertake this validation exercise.

2.1.2 Validation of Weather Huffman (WH) compression scheme

The representative of NCEP, Mr Jeff Ator reported on the study NCEP made for running some comparison tests of WH vs. the existing GRIB2 compression schemes JPEG2000, PNG and 1st and 2nd-order packing, using 12 pre-formatted radar reflectivity images. In all cases, the WH results were quite impressive and provided superior compression results vs. the other existing schemes, although WH was developed specifically for compression of radar reflectivity images, where values tend to increase and decrease smoothly (i.e. no abrupt jumps) and where regions of higher data values tend to be fully enclosed within regions of lower data values. In other words, WH is highly-optimized towards its intended target application and therefore not necessarily an efficient general-purpose compression algorithm. So it would be interesting to see how WH performs on other types of weather-based data such as satellite imagery and/or model output grid fields such as temperature, wind speed, etc..; such future studies might be conducted. The team noted that the document explaining the WH compression algorithm was 80 pages long. The Team was told that there were proprietary rights for the compression/de-compression software. Independent software would need to be developed by other organizations.

The Team was in favor of approving WH as a compression option within GRIB2 at some future stage provided that (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. If these conditions were met, then the ET/DR+C would work with ICAO to undertake validation.

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

ECMWF presented a proposal to add parameters in the Code Tables to represent data related to aerosols. They will be used in the GEMS project as the model output parameters in GRIB 2. They will be included in the table for Product Discipline 0: Meteorological products, Parameter Category 13: Aerosols. The team recommended that the proposal be refined, if possible with good definitions for May 2006, when it could be revisited.

2.1.4 Addition of check-sum

ECMWF presented a proposal to have quality assurance with GRIB 2 messages. The experience showed that during handling of the huge volume of binary data some data corruption happened despite existing system checks. Therefore it would have been very useful to incorporate the checksum value and the method in the GRIB 2 message. The Team felt however that the check sum should be outside the data representation. It was stressed also that changing the physical layout of the message would require a new GRIB edition. The experts considered that the check-summing was not a data representation issue but that it was an exchange or retrieval issue. It should be done outside the data representation and it should be done by telecommunications, or retrieving applications.

2.2 Other additions or modifications

2.2.1 Additional Code table entries for METEOSAT data

In response to evolving user requirements, EUMETSAT had implemented two new products encoded in GRIB for fire detection and clear sky radiance data. In order to make the data available as quickly as possible, local code table entries had been used. EUMETSAT made a proposal for official code table entries to allow the standardization of the data representation. The Team agreed and recommended the new entries as listed in Annex to this paragraph as pre-operational.

2.2.2 Addition to product status and new parameters

ECMWF expressed the need for a new entry in the Code table 1.3 to flag TIGGE data in order to be able to distinguish between operational data and data contributed to the TIGGE project. An additional parameter was also required for TIGGE for total column water. The Team agreed for these additions (see Annex to this paragraph) and recommended them for pre-operational status.

2.2.3 Comments on GRIB 2

2.2.3.1 ECMWF expressed concern about differences between GRIB edition 1 and GRIB edition 2 packing. One expressed the idea that encoding a field in GRIB1 followed by decoding of that field may result in different decoded values compared with GRIB2, but these differences will be of the order of the quantization error. The nature of the problem was not clear from the document provided and it was not clear what, if any, action was needed to fix the problem. The team agreed to request that ECMWF clarify the question with specific examples of fields causing the problem, so that the question could be re-considered at the next meeting of the team.

2.2.3.2 ECMWF noted that some GRIB edition 2 Code tables incorrectly had 255 as the missing value where another value, such as 65535 should be used, without specifying which tables were affected. The team did a search of the GRIB 2 documentation for such cases and the required changes are listed in the Annex to this paragraph.

2.2.3.3 It was also pointed that there was a discrepancy in data representation template 4.30 where one octet was allocated for the instrument type) while the recommended code table required more than one octet (Common Code table C-8 with 2047 bits). In order to allow for proper testing, the team decided to defer consideration of how to remedy this situation until the next meeting.

2.2.3.4 ECMWF noted that there was no explanation of packing in the GRIB edition 2 data templates. The description of packing was incorporated in the GRIB edition 2 regulations (regulation 92.9.4). The team recommended that notes be added to clarify the situation as listed in the Annex to this paragraph.

2.2.3.5 ECMWF noted that the documentation for irregular grids was inadequate. The document provided was inadequate and the team could not determine what the actual problem was in all cases. Some additions and clarifications were recommended as listed in the Annex to paragraph 2.2.8, but these might not be enough to address the concerns of ECMWF.

2.2.3.6 ECMWF requested that a product version number be added to GRIB 2, and suggested using octet 22 of section 1. The team noted that this would require a new GRIB edition, which was not desirable. The appropriate location for a version number was within the product definition template. If ECMWF or any other user has a need for a version number they should propose a new product definition template or templates and submit these to the team.

2.2.4 ECMWF requested lossless packing of IEEE floating point numbers. No proposed data representation template was provided. The information provided by the ECMWF was inadequate to develop a template at this stage. Questions that needed to be answered before a template could be developed included:

- Does LZW compression have any parameters, such as the maximum dictionary size, the initial dictionary size or if variable length encoding is used? What does “LZW with horizontal differencing” mean. Is it one or two dimensional differencing ? How are the differences calculated?

- How are the symbol boundaries in the LZW compression algorithm determined?

The team recommended that ECMWF should examine the data representation templates for JPEG 2000 and PNG compression and propose a proper data representation template for consideration at the next meeting of the team.

2.2.5 Addition to GRIB Edition 1

DWD had a requirement for high resolution regional models with forecast times up to 3 days which needed output sequences of GRIB files less than 1 hour. Using GRIB Edition 1, this was only possible by allowing indicators of unit of time range (IUTime) with values 1 minute < IUTime < 1 hour. Values of 15 and 30 minutes were appropriate. The GRIB`s model outputs were exchanged internationally. Within DWD GRIB Edition 1 would remain operational for some time. The Team agreed that this addition in GRIB 1 Code Table would not affect ICAO, which was the reason for freezing GRIB Edition1. It would not either affect any GRIB 1 decoder program, unless the specific time of fields needed to be identify. Therefore the Team agreed to add this entry as defined in Annex to this paragraph.

2.2.6 GRIB Master Table Version Number

The Meeting 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) Code figure 0 (experimental) could be used on a pre-operational basis, however, the code figure shall be changed to that of an operational version number when the operational implementation date of the pre-operational descriptors has come.

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 the solution defined in Annex to this paragraph and thanked JMA representatives for their work to reach that solution.

2.2.7 Additional parameters for the UV Index

The Global Solar Ultraviolet Index (UVI) forecasting had already been implemented in many countries. The Japan Meteorological Agency (JMA) had been also providing the UVI through its web page, which was a simple measure of the UV radiation level at the Earth’s surface and an indicator of the potential for skin damage. Two UVI under different conditions were produced, because the UVI depended on cloud. One was produced on the assumption that there was no cloud and the other was calculated in accordance with forecasted cloud. The UVI was developed in an international effort by the World Health Organization (WHO) in collaboration with the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ("Global Solar UV Index, A Practical Guide", 2002). The Team agreed to add the corresponding parameters as defined in Annex to this paragraph. However since it was dimensionless numeric value, the Team recommended that a note defining the Index be added to the table.

2.2.8 Quasi-regular (sub-)grids and precipitation parameters

1) *Quasi-regular (sub-)grids*

The Team considered a proposition submitted by Meteo-France. In GRIB edition 2, there was provision to handle quasi-regular grids. As an improvement as regards GRIB1, an indicator was set to cope with the two main uses of such grids:

- Gaussian grids (as used in global or hemispheric spectral NWP models)
- Limited area sets (such as WAFS products, i.e. “thinned GRIBs”)

This indicator corresponds to Code Table 3.11, where entries 1 and 2 may be associated respectively to the above-mentioned cases.

The retrieval service of ECMWF local archive system had the capability to extract sub-area from regular latitude-longitude or Gaussian grids, but also from a quasi-regular Gaussian grid. In this case, GRIB2 did not seem appropriate. At first thought, some additional entries were felt necessary to handle such case, as a compromise not to build additional templates. However, it was realised after some time, that there was enough flexibility within entry 1 of the code table to deal with the sub-area case from a global (or hemispheric, or periodic) quasi-regular grid. For each row, there was the possibility at decoding time to compute the coordinate values on the “variable” one (longitudes):

- as long as the extreme coordinate values of the set were encoded into the grid definition template (as the first/last coordinate values)
- using the explicit rule of coordinates multiple of the circle mesh

However, some extra wording should be added to entry 1 of such code table (see Annex to this paragraph). The Team agreed that it should be noted that depending on values of extreme (first/last) coordinates, and regardless of bit-map, effective number of points per row may be less than the number of points on the current circle.

It was also recommended that note (3) within Grid Definition Template (GDT) 3.0 should be duplicated for all other GDTs which might be associated to quasi-regular grids (see Annex to this paragraph).

2) *Precipitation parameters*

Meteo-France indicated that there was an ambiguity within GRIB2, which had been inherited from GRIB1, as regards precipitation parameters. Within Code Table 4.2, Product Discipline 0 - Meteorological Parameters, Category 1: Moisture, one could read as regards accumulated precipitation:

8	Total precipitation	kg m^{-2}
9	**Large scale precipitation (non-convective)**	**kg m^{-2}**
10	**Convective precipitation**	**kg m^{-2}**
14	Convective snow	kg m-^{2}
15	Large scale snow	kg m^{-2}

This was consistent with Code Table 2 of GRIB1, but it was not explicit what phases of precipitation were included within “Large scale precipitation” and “Convective precipitation” (entries 9 and 10).

Within Meteo France (1992/1993), the appreciation was that due to the presence of specialised entries for snow types, the entries were independent, and thus that only liquid (water) phase was included. However, years later, it appeared that UKMO did include both phases and ECMWF as well (though with local entries). So there was currently no proper answer, and the actual ambiguity should be removed before extensive use of GRIB2. Furthermore, there was no proper way to document (total) snow precipitation, nor (total) water precipitation. One might use the “Snow melt” parameter for the former, but this was questionable. The Team agreed to the proposal ias follows (see Annex to this paragraph):

- keep current entries in GRIB2, but add a note for entries 9 and 10 stating that all phases are included (provided it is the most used approach)

- add entries for: large-scale water precipitation, convective water precipitation, total water precipitation, total snow precipitation

2.3 Report on experimental and operational exchanges of fields in GRIB2

In order to make its data readily accessible to its users, EUMETSAT had decided that all image type products would be encoded in GRIB Edition 2 (GRIB2). A range of products was generated, and these were available variously via the EUMETCast DVB multicast service, via download from EUMETSAT's web site, via anonymous FTP and via offline delivery from EUMETSAT's archive.

When complex packing was used, the encoding was performed using NCEP's C GRIB2 encoding library available from NOAA's web site (http://www.nco.ncep.noaa.gov/pmb/docs/grib2/). This software packed the data very efficiently, but required enormous amounts of memory for encoding and decoding satellite data. When simple packing was sufficient, EUMETSAT's own software was used for the encoding.

EUMETSAT delivers products in GRIB2 format: Cloud Mask (CLM), Cloud Top Height (CTH), Cloud Analysis Image (CLAI), Clear Sky Reflectance Map (CRM), Multi Sensor Precipitation Estimate (MPE), Fire Detection Product (FIR). These products are described in detail in Annex to this paragraph. Some of the products use bit-maps and some don't. Some use complex packing and 3rd party software and some use simple packing. Some products are available via EUMETCast, and some via the Internet.

There had been considerable interest in these products. It had often been necessary to provide software for decoding the data. Some users were satisfied with simple product specific decoding examples, and others had been directed towards generic decoding software.

The Team congratulated the EUMETSAT representative for this achievement and requested other centres to advertise also their available GRIB 2 products.

3. BUFR AND CREX

3.1 REVIEW OF ENTRIES AWAITING VALIDATION FOR BECOMING PRE-OPERATIONAL

The Team considered the present list of Table entries awaiting validation. It was considered that only the descriptors related to SYNOP and SHIP Observations could be considered as pre-operational, and the descriptors for that will be taken from the validated templates (see Annex to this paragraph). The VOS observation descriptors would remain for validation. The remaining entries for validation are listed in Annex to this paragraph. It was recommended that descriptors for radiation be validated before May 2006. TRACKOB, RADOB and SAREP data were reviewed further in paragraph 3.10.8.

3.2 NEW DESCRIPTORS FOR AIR CHEMISTRY

The Team considered a proposal submitted by Yves Pelletier and Yves Rochon from Canada. The proposed additions to the BUFR table B were intended to provide a framework suitable for the reporting and forecasting of atmospheric constituents in disciplines related to Air Chemistry.

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. This was a process with at least two phases. The first phase would cover:

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

The second and subsequent phases might cover:

- Instrumentation
- Representation of more complex species, such as particulate matter
- Descriptor sequences suitable for Table D

The Team agreed to deal with questions arising from items 3.2, 3.9 and 3.10.3 at the same time, as the three items were closely related. To facilitate future discussion, the Team agreed that the proposal of 3.9 would be merged into the proposal of Canada. The merged version will be revisited at the next meeting.

With some modifications, described in Annex to this paragraph the Team agreed that the proposed new descriptors would now enter validation mode, with a view of being approved for pre-operational use at the May meeting in Montreal.

3.3 SIGMET IN BUFR

Following an original joint proposal presented to a previous ET/DR+C meeting in Prague (April 2002) by the representatives of Australia and ICAO for the encoding of volcanic ash SIGMET messages into BUFR, the U.S. National Weather Service's Aviation Weather Center (NWS/AWC) proceeded during the subsequent year to expand the proposal to include a methodology for the encoding of all types of SIGMET messages into BUFR. The proposal was further refined during subsequent meetings of the ET/DR+C in Arusha (February 2003) and Kuala Lumpur (June 2004) and was then finally validated during the past year when test SIGMET messages generated by the NWS/AWC were successfully decoded and feedback provided with the kind assistance of representatives from ECMWF, DWD and the Czech Hydrometeorological Institute. The U.S. representative gratefully acknowledged the efforts of all who participated in helping to bring this proposal to fruition, and asked that the attached proposal be accorded pre-operational status.

The Team thanked USA for this undertaking. The Team however would like to be sure that all of the examples of SIGMET in ICAO Annex 3 could also be encoded and decoded. The Team recommended that declaration for pre-operational status should be sought for May 2006.

3.4 RADIOSONDES LIST PROBLEM

The Team considered that this was not a problem anymore since many manufacturers of radiosondes were committed to disseminate the data in BUFR. There would be also a catalogue of radiosondes used in the countries and that would provide the necessary information.

3.5 MASTER TABLE FOR SATELLITE DATA

The Team discussed the issue of making a new master table for satellite data. Three main problems were identified: the management of the new Master table, the respect of BUFR regulations, especially for additions, and the implementation of the process. Starting new Master Table would require some coordination and commitment from the parties concerned.

Whether the requirements for representing new satellite data in BUFR were met by the introduction of a new BUFR Master Table or by the allocation of specific classes of descriptors, the co-ordination of this process would be simplified by the involvement of an independent group of experts, in this case such a group could be a Working Group of CGMS.

The Team agreed to refine the definition of the role of new BUFR Master Tables, together with their scope and the criteria for their establishment. In that line, it recommended some revision to the Manual as listed in Annex to this paragraph.

3.6 REQUIREMENTS FOR GTS DISTRIBUTION OF OCEAN DATA

The representative of IOC submitted to the Team a set of proposals related to the exchange of ocean data on the GTS.

1) The Team agreed that common sequence number had to be finalized for all templates defined for exchange of operational data in BUFR, including oceanographic ones. These can be found in the Annex to paragraph 5.4.1, where all the templates are listed.

2) A new template was proposed by DBCP for buoy directional and non directional wave data (see Annex to paragraph 5.4.2):
The Data Buoy Cooperation Panel had proposed a new template for buoy data to include directional and non directional wave data measured by buoys (e.g. Puertos del Estado – Moored Buoy programme) as well as data which could be included in the WAVEOB format. It was noted also that UK Metoffice was receiving buoy data sent by CFAS (UK organisation taking care of buoys), which were called wave net data (see Annex to paragraph 5.4.2). It was a sub-set of the DBCP proposal with some minor differences. UKMO was investigating the impact of change

needed to the DBCP proposed template. The Team agreed this template needed to be validated seeking pre-operational status in May 2006.

3) The Argo Data Management Team had proposed a new template to represent sub-surface floats, including two new Table B descriptors and new entries in Code Table 008080. The Team agreed that the new template should be considered for validation before May 2006.

4) Regarding Test SHIP reports, the expert team agreed that it was a matter to be referred by the JCOMM – SOOP group to the GTS expert teams. For data content test message should have a TEST+Country, for call sign. Decoder will have to reject such data for further processing.

5) The Team recommended the inclusion of entries in Common Code C-3 for animal instruments as listed in Annex to this paragraph.

3.7 NUMBER FOR PRE-OPERATIONAL TABLES AND LOCAL TABLES

The Team agreed that the system of table numbers defined for GRIB 2 in paragraph 2.2.6 was also appropriate for BUFR, and the Team entrusted the secretariat to develop a proposal in these lines which will be examined by the members of the Team.

3.8 ADDITION OF CHECK-SUM

As stated in paragraph 2.1.4 for GRIB 2, the Team rejected the inclusion of check sum in the BUFR message.

3.9 PARAMETERS FOR GEMS

The GEMS project will develop and implement at ECMWF a comprehensive global data assimilation/forecast system for atmospheric dynamics and composition. The model will use all available data to achieve global monitoring. The monitoring will include atmospheric constituents with:

a) greenhouse gases
b) reactive gases
c) aerosols

It was planned to use BUFR format for the representation and exchange of the observational data. In general, there was a need to represent chemicals in the BUFR form. The Team agreed that these requirements, expressed by Martin Suttle from ECMWF, will be merged with the proposal from Canada. (see paragraph 3.2). The new descriptors will be considered for validation, with a view to their pre-operational recommendation in May 2006.

3.10 VARIOUS NEEDED ADDITIONS OR CORRECTIONS

3.10.1 Clarifications to BUFR Regulations

Certain problems have been met during development of the BUFR encoding/decoding Software in the Czech Hydrometeorological Institute. To solve these problems, some additions to regulations or modifications had been proposed by Eva Cervena. The Team considered these proposals and agreed to recommend the changes as listed in Annex to this paragraph.

3.10.2 Additional satellite identifier for AURA satellite

The Team recommended the allocation of a new entry in the Common Code Table C-5: Satellite identifier, for the AURA satellite, as listed in Annex to this paragraph:

3.10.3 New entries for reporting of particulate matter

At the previous ET/DR+C meeting in Kuala Lumpur (June 2004), formal pre-operational approval was given to several descriptors that had previously been allocated (and subsequently validated) for use by the U.S. Environmental Protection Agency (EPA) in reporting ozone concentrations in BUFR/CREX. The USA representative, Jeff Ator indicated that EPA would now like to begin developing similar products for the reporting of concentrations of fine particulate matter, which consisted of random particles of dust, dirt and other atmospheric contaminants trapped within a monitoring filter from a given volume of air and then measured by mass. The Team combined these requirements with those expressed in paragraph 3.2. (see Annex to paragraph 3.2)

3.10.4 Some simple additions to existing Code tables

NCEP required additional entries and these were recommended by the group as listed in Annex to this paragraph.

3.10.5 Proposal for new entries in Flag table 0 08 042

The Team agreed to recommend 3 new entries in the flag table 0 08 042 (Extended vertical sounding significance) needed for representation of PILOT and TEMP data in BUFR as listed in Annex to this paragraph.

3.10.6 Additional Code table entry for satellite data

At present code figure 13 is reserved in the Height Assignment Method code table, 0-02-163. All other entries in the table are defined. The Team agreed to recommend the use of code figure 13 to represent the " IR / two WV channel ratioing method " as listed in Annex to this paragraph.

3.10.7 Additional entries for polar satellite data

The successful launch of NOAA 18 marked the start of the Initial Joint Polar System (IJPS), being operated by NOAA and EUMETSAT. On NOAA 18, the AMSU-B instrument previously in the ATOVS package has been replaced by MHS (the Mircowave Humidity Sounder), supplied by EUMETSAT. Within the context of the IJPS, EUMETSAT plans to launch the first of its polar spacecraft, METOP 2, in June 2006. In addition to EUMETSAT's instruments: GRAS (a radio occultation sounder), GOME2 (a high resolution spectrometer), IASI (a hyperspectral sounder), ASCAT (a scatterometer), and MHS, the spacecraft will also have AVHRR, AMSU-A and HIRS instruments from the USA.

Data from AMSU-A, MHS, HIRS, IASI, GRAS and ASCAT will be exchanged in BUFR. In order to represent data from the new instruments, new BUFR element descriptors, sequence descriptors, and code and flag table entries required. The Team agreed to recommend these entries as pre-operational before May 2006 when proper descriptor numbers will be allocated. The Team insisted, however, that unclear abbreviations be replaced or supplemented by understandable names. The additions are found in Annex to this paragraph.

3.10.8 Entries in BUFR Tables B and D for new templates of RADOB, TRACKOB and SAREP

Exchange of TRACKOB data in BUFR

The Japan Meteorological Agency (JMA) is collecting reports of marine surface observations in FM62 TRACKOB from Voluntary Observing Ships through the INMARSAT and distributing them through the Global Telecommunication System (GTS). In accordance with the migration plan, a BUFR template for TRACKOB data as well as necessary descriptors and code tables were drafted by JMA. A validation test was carried out with the kind help from the European Centre for Medium-Range Weather Forecasts (ECMWF) and successfully completed. The experimental exchange of TRACKOB data in BUFR started in November 2005.

Exchange of RADOB and SAREP data in BUFR

JMA has been producing tropical cyclone information in FM85 SAREP, which is derived from Japanese geostationary satellite. Also, JMA and some members of the ESCAP/WMO Typhoon Committee (hereinafter referred to as TC) have been producing tropical cyclone information in FM20 RADOB, which is derived from radar observations. These products are being exchanged between the members of TC for disaster prevention and mitigation activities according to the Typhoon Committee Operational Manual, Meteorological Component (Report No. TCP-23). In accordance with the approval at the 37th Session of TC (Shanghai, China, Nov. 2004), BUFR templates for SAREP and RADOB data were drafted by JMA with necessary descriptors and code tables. Validation tests were carried out with the kind help of ECMWF and successfully completed. Distribution of tropical cyclone information in BUFR from JMA started in November 2005.

Table D descriptors for RADOB, TRACKOB and SAREP

At the meeting of the Coordination Team on Migration to Table Driven Code Forms (CT/MTDCF) held in Geneva, November 2005, it was recommended to create one Table D descriptor for each whole sequence of RADOB, TRACKOB and SAREP.

The Team considered the required new additions to Code tables and agreed that after checking the numbering of descriptors for consistency with other requests, and clarifying some terminology with possibly notes at end of some table, the:

1) Descriptors and code tables for the templates of RADOB, TRACKOB and SAREP, as listed in the PART A of the Annex to this paragraph be recommended for pre-operational status.
2) In accordance with the recommendation from the meeting of CT/MTDCF, three Table D descriptors for RADOB, TRACKOB and SAREP Templates, as listed in PART B of the Annex to this paragraph, were recommended for validation.

3.10.9 Errors in the Manual on Codes

The Team was informed that several errors had been found in the hard copy of the last supplement to the Manual on Codes. The secretariat was aware of these mistakes and a corrigendum was in preparation to fix the mistakes, which may have an importance for substance of the information. Less important errors (mostly typos) will be fixed in the next supplement in 2007.

3.10.10 Compression

Following a remarks by experts from the group dealing with the WIS implementation, that compression should be done after representing the data and not included in the data representation form rules, the Team discussed that issue, and stated that compression should guarantee accessibility of data for anybody, which mean to have access to decompressing software. Some good compression can be very costly. Compression and decompression algorithm can also be very costly in computer time. So far, WMO had defined compression algorithms independent of licensed software. The Team also recalled that one could still compressed BUFR data themselves and one could gain 20 % gain on top of compressed BUFR. This was used for satellite data. It was found that at the beginning of the report it can be a good option to keep the metadata uncompressed, for immediate and easy reading, the compression being reserved to the actual data (in the data section). Tests of compressed XML, CREX and NetCDF had showed that they were not as good as BUFR. It was also noted that in one particular example BUFR was seven times smaller than compressed NetCDF.

4. MODIFICATIONS TO TRADITIONAL ALPHANUMERIC CODES

4.1 NEW MODIFICATIONS TO AERONAUTICAL CODES

4.1.1 ICAO proposals

ICAO passed to the Team for consideration the proposed changes to the aeronautical codes FM 15, FM 16 and FM 51, which formed a part of draft Amendment 74 to ICAO Annex 3/ WMO Technical Regulations [C.3.1.]. Additional requirements concerning SIGMET were also given. ICAO stressed that the proposals were subject to consultation with States and, as such, were not finalized. The consultation process was expected to take place between February and May 2006 with a final review by the ICAO Air Navigation Commission expected before the next meeting of the WMO Commission for Basic Systems (November 2006). The Team agreed that the proposals looked correct, however the members of the Team were asked to review the amendments and put any question to the ICAO secretariat (Mr Neil Hasley) for any required clarification or question arising. The Team thanked Mr Neil Hasley for this good preparatory work.

4.1.2 Calendar of implementation of changes

The 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 were listed below.

For operational implementation in November 2007 or November 2008:

- Study of proposed changes by ET/DR&C in Muscat, Oman 5-8 December 2005

- Recommendation to CBS of changes by Expert Meeting on Codes in ICAO, Montreal 1-5 May 2006

- Endorsement of recommendation to CBS of changes by ICT on ISS in Geneva, July 2006

- Recommendation of changes by CBS, Seoul, Korea November 2006
- Final approval of CBS recommendation by EC in June 2007
- Operational implementation in November 2007 or November 2008

For operational implementation in November 2009 or November 2010:

- Study of proposed changes by ET/DR&C in 2007
- Recommendation to CBS of changes by Expert Meeting on Codes in 2008
- Endorsement of recommendation to CBS of changes by ICT on ISS in 2008
- Recommendation of changes by CBS in 4th quarter 2008
- Final approval of CBS recommendation by EC in June 2009
- Implementation in November 2009 or November 2010

4.1.3 Inclusion of definitions of Prevailing visibility and Visibility in Manual on Codes

The Team discussed the possibility of inserting the definitions of visibility and prevailing visibility in the Manual on Codes. However, since these definitions were developed by ICAO and susceptible of evolution or modifications, the Team agreed that it was preferable to simply add notes in the Manual referring to the definitions of visibility and prevailing visibility in ICAO Annex 3/ WMO Technical Regulations [C.3.1.].

4.2 ICAO TAC TEMPLATES

Mr Charles Sanders (Australia) 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). Differences noted included:

METAR and SPECI

i. The ICAO template has AUTO and NIL as alternatives, the WMO code form permits both.
ii. The WMO regulations do not mention the word NIL.
iii. The WMO code form allows for the use of metres per second as units of wind speed.

The differences are minor and probably do not require anything more than editorial changes.

TAF

i. The ICAO template has AMD and COR as alternatives, the WMO code form allows both.
ii. The WMO code form allows for the use of metres per second as units of wind speed.
iii. The WMO code form has the change and time indicators before the forecast maximum and minimum temperatures, the ICAO template has the change indicators after.
iv. The WMO code form does not include the changed weather elements after a change indicator.

The regulations are mostly satisfactory and probably do not require anything more than editorial changes. The code form does require amendment, in particular to place the maximum and minimum temperature groups before the change groups and to include weather elements after the change groups.

The secretariat was tasked by the Team to consult with ICAO to see if these differences needed a corrigendum to be issued.

4.3 THUNDERSTORM REPORTING

The UKMO had passed a document requiring possible changes in the Codes regulations related to the reporting of thunderstorms. The Team considered that the potentially needed changes to the SYNOP regulations required more thinking and elaboration to find out where and how regulations in Manual had to be changed. The Team entrusted the UKMO representative to define a clearer proposal for necessary addition to SYNOP regulations. The Team also agreed that ICAO needed to be contacted by UKMO to discuss the possible changes to METAR/SPECI regulations.

5. IN RELATION TO MIGRATION TO TABLE DRIVEN CODE FORMS

5.1 PROPOSED OBSERVATIONS REPORTING PRACTICES FOR TDCF IN MANUAL ON CODES

5.1.1 Background

The Manual on Codes, Volume I.1, contains more regulations related to reporting practices than formatting rules. The Volume I.2, on the contrary defines formatting systems, and practically no reporting regulations. The Volume I.1 links reporting practices to the alphanumeric coding format. The migration to BUFR/CREX will push producers and users (human encoding or decoding and encoder/decoder software programmers) of BUFR/CREX codes to consider Volume I.2, rather than Volume I.1. It was necessary to re-write the regulations on reporting practices connected with the traditional alphanumeric codes (TAC), and produce a new set of regulations for reporting TAC data in BUFR or CREX.

5.1.2 Proposal for producing regulations for reporting TAC data in TDCF

The Annex to this paragraph contains a set of regulations for reporting SYNOP data in BUFR/CREX. The Team thanked especially Dr Eva Cervena for all the work she performed to prepare the Templates for converting traditional alphanumeric codes in BUFR and also the work on developing reporting practices for TDCF. The Team considered the provided example of proposed reporting practices and agreed that this was the right approach. The Team recommended that the available developed reporting practices be checked before May 2006 and before July 2006 (OPAG on ISS meeting).

The following problems have been solved and clarified:

5.1.2.1 System of numbering of the regulations for reporting some TAC data in TDCF

The regulations in the Annex are specified by the same numbers as the corresponding regulations in SYNOP. However, the order of elements in the BUFR template for SYNOP data differs significantly from the order of elements in the traditional SYNOP. Consequently, the regulation numbers in the Annex are not increasing which would make their usage rather difficult. Therefore, it is proposed to create a new system for numbering of the regulations, e.g.

B/C1 – Regulations for reporting SYNOP data in BUFR/CREX,
B/C2 – Regulations for reporting SYNOP MOBIL data in BUFR/CREX,

B/C3 – Regulations for reporting SHIP data in BUFR/CREX, etc.

The numbers of the regulations for each type of data could be then numbered in the increasing order in compliance with a standard BUFR template recommended for the data type. For reference, the number of the corresponding TAC regulation might be included at the end of the regulation, written in italics.

5.1.2.2 Additional elements

The BUFR templates defined for some TAC data (to help the migration process) contain not only the elements reported in the corresponding traditional codes, but also other important information. The regulations for reporting TAC data in BUFR/CREX should address also these additional entries (e.g. horizontal and vertical coordinates of the observation site, position of sensors and significance qualifiers, vertical significance).

5.1.2.3 Units

With each element introduced within the regulations, the unit and the required precision should be specified. If different units were used in BUFR and CREX, the unit in which the element value was reported in CREX should be also mentioned.

5.1.2.4 Reference to descriptor numbers in the regulations

Prevailing part of the text in the Annex does not refer to the sequence descriptor numbers used in the BUFR template for SYNOP data, and SYNOP symbolic letters are used only exceptionally in the text of the regulations. However, reporting clouds with bases below station level is described using BUFR sequence descriptors and SYNOP groups and symbolic letters. Explicit reference to the sequence descriptor numbers in the regulations would practically exclude the proclaimed flexibility of TDCF. On the other hand, supplementing each described element with its B-Table number might be helpful (up to now, the B-Table numbers have been added only in part of the text).

5.1.2.5 Description of entries of Section 1

The Team approved the need of description of the entries of Section 1 within the Reporting practices or at least some of them e.g. data category and subcategory or datum/time entries in Section 1. The time of observation reported in the Data section may differ significantly from the "most typical" time in Section 1 (standard time corresponding with YYGGgg in the abbreviated telecommunication header), e.g. in case of reporting PILOT and TEMP data in TDCF.

5.1.2.6 Miscellaneous explanatory additions

The text of the Reporting practices may require inclusion of explanatory notes, e.g.

- Based on the suggestion from the JMA, the description of temperature elements has been supplemented by notes explaining why temperature data should be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree.

- Reporting practices should primarily refer to the procedures relevant for producing of the data in TDCF at the observing site. However, collecting of the data in TAC and converting them into TDCF in the centre has to be considered and the Reporting practices should adequately cover this issue.

5.1.3 Identification of templates

The Team considered a proposal from JMA to attribute identifier to templates. The Team agreed that it was a good idea in principle, however the Team retained a different system where the sequence number attributed to the template would be indicated, like: "TM <sequence number>

E.g.: **TM 307080 Synoptic reports from fixed land stations suitable for SYNOP observation**

For CREX it would be:

TM D07080 Synoptic reports from fixed land stations suitable for SYNOP observation

The Team also noted that different named templates could have the same definition if they use the same sequence number.

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

Dr Eva Cervena presented a proposal for templates covering regional practices. It was proposed to supplement the existing global BUFR templates for SYNOP and TEMP data by relevant additions, reflecting the reporting practices in the particular region. Regional coding procedures related to the other TAC do not require any additions to the corresponding BUFR templates. The proposed templates and new descriptors were presented at the Meeting of CT MTDCF that was held in Geneva, from 1 to 4 November 2005. Based on the suggestion of the CT MTDCF, sequence descriptors have been proposed for regional BUFR templates for SYNOP data. Validation of these regional templates might be done in cooperation with the Working Groups on Planning and Implementation of WWW in RAs. The Team was impressed by the work accomplished and recommended that these templates (see Annex to this paragraph) be validated.

5.3 TEMPLATES FOR NATIONAL PRACTICES

A way of representing national practices in TDCF was presented by Dr Cervena, as listed in Annex to this paragraph. The Team agreed that it was a good example to show how this could be done, but that it was not necessary to develop these templates for all the countries and that it was the responsibilities of the country concerned. However this could be used to show how to implement this nationally. It was also recalled that normally data related to national practices were not exchanged internationally; therefore it did not need to be systematically recorded. Only regional practices should be in recorded templates. They could also be put in a separate BUFR message if they needed to be exchanged. Another solution was to use local descriptors in conjunction with operator 2 06 yyy. This was a procedural issue, which needed more consideration, and the Team wished to generate more firm recommendations for May 2006.

5.4 REVIEW AND DEFINE NEEDED TEMPLATES AND COMMON SEQUENCES

5.4.1 List of all templates

Dr Eva Cervena presented to the Team an updated and reorganized set of templates for representation of TAC data in BUFR or CREX. Strictly speaking, the templates presented were BUFR templates; if used for CREX, relevant modifications would have to be introduced. The Templates were reordered according to migration categories. The Team congratulated Dr Cervena for this excellent and meticulous work. The BUFR templates presented should provide facilities for representation of data reported in the Traditional Alphanumeric Codes described in the international part of Manual on Codes, WMO-No. 306, Volume I.1. Successful migration to Table Driven Code Forms will require also the coverage of regional and national reporting practices that are published in Manual on Codes, WMO-No. 306, Volume II. If required, the global template for the particular data types may be supplemented by relevant additions, reflecting the reporting regional or national practices as discussed paragraphs 5.2 and 5.3, respectively. BUFR templates for vertical profile data and templates for aircraft ascent/descent profile data had already regulatory status as so-called "common sequence numbers" were approved by CBS. For most of the other templates, following their validation, sequence descriptors for BUFR Table D were proposed. A BUFR template for SAREP data (Part A: Information on tropical cyclone), developed and validated by JMA, had been added.

The Team recommended to add Note (4) under template 3 09 050 (Wind vertical profiles suitable for PILOT, PILOT SHIP and PILOT MOBIL observation data with pressure as the vertical coordinate). This addition was considered to be sufficient for solving the problem noted by Mr. W. Qu (Australia), i.e. the complete vertical wind profile may be represented in BUFR using only common sequence 3 09 050, even if maximum wind data and/or wind shear data are reported with height as the vertical coordinate in Parts A or C of PILOT report, while the whole vertical wind profile is reported with pressure as the vertical coordinate. Maximum wind data are as significant levels included also in Parts B or D and therefore reported with pressure as the vertical coordinate in Parts B or D.

> Note (4): If maximum wind data and/or wind shear data are reported with height as the vertical coordinate in Parts A or C of PILOT report, while the whole vertical wind profile is reported with pressure as the vertical coordinate, the data may be converted into BUFR using sequence 3 09 050 because the maximum wind data are as significant levels also included in Parts B or D (being identified by pressure as the vertical coordinate).

The Team agreed that there should be two templates for buoy measurements: one without and one with wave data measurement. Automatic Weather Station Templates and other should be put in other available BUFR Templates. The AMDAR simple template should be removed. Templates for SYNOP data reported from coastal stations should be included.

The Team stressed again that defining standard templates was necessary for avoiding anarchy and mistakes in the transmission of basic synoptic observations and there was a need for a basic list of templates for migration. However, in the data processing, the programs should look for identified decoded parameters, rather than ranked parameters in the decoded list, to be sure to process the right information.

The Team asked the Secretariat to update the server files with this new finalized list of templates (see Annex to this paragraph).

5.4.2 Proposed BUFR template for buoy wave data

At its 20th session, the Data Buoy Cooperation Panel (DBCP) expressed concern that there was no BUFR template defined for wave data reported from buoys. The Technical Coordinator of the DBCP and Météo France had worked during the DBCP intersessional period to draft a new template for buoy data. The latter had been discussed and agreed upon by the DBCP at its 21st session, Buenos Aires, 17-21 October 2005, and the Technical Coordinator was asked to submit it to the CBS Expert Team on Data Representation and Codes for discussion, possible amendment and adoption. There was the need for a buoy wave template because there were a number of directional and non-directional wave buoys deployed that reported their data in real time. FM-65-XI Ext. WAVEOB format was usually being used for GTS distribution of the data.

New BUFR template for buoy wave data herewith proposed would:

(i) Meet needs of all users of wave data;
(ii) Include additional descriptors corresponding to fields that appear in WAVEOB format;
(iii) Remain compatible with the BUFR template for buoy data that was adopted by the CBS Expert Team on data representation and codes at its Arusha meeting, 17-21 February 2003, which was now being used operationally by Service Argos for GTS

distribution of buoy data in BUFR. Compatibility would be ensured by just adding new required descriptors at the end of the existing template.

The representative of IOC proposed a draft BUFR template as described in Annex to this paragraph.

The Team considered that this template should be more validated seeking a pre-operational status by May 2006.

5.4.3 Expressed requirement for Radiosonde templates

A proposal for radiosonde template was handled to the Secretariat by Mr John Nash, Vice-President of the CIMO Commission (see Annex to this paragraph). The concern of UKMO was the need to put metadata at the beginning of the report. At least a minimum set of metadata should be agreed internationally for the beginning of the report. At the end of the report other metadata could be included at the discrepancy of the producer. The need to replace dew point temperature by relative humidity was expressed. This value was more accurate than the due point, which was a calculated value. The Team agreed that this would be another template for high-resolution radiosonde data. This template needed to be refined and discussed between UKMO and NWS, USA. The Team agreed that it should be finalized in May after contact with manufacturers. The Team asked the Secretariat and the UKMO representative to finalize this proposal.

5.5 REVIEW METAR/SPECI/TAF TEMPLATE

Mr Charles Sanders (Australia) had reviewed the existing proposed METAR/SPECI/TAF BUFR templates (see Annex to this paragraph). It was noted that the current table D descriptors did 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 Team stressed that approval of ICAO would be needed for this, and the Team recommended that this work be finalized and submitted to at least the OPAG on ISS in July for approval by CBS (action: Charles Sanders, Eva Cervena, ICAO (Neil Halsey, Oli Turpeinen) and Jeff Ator (if more help needed)) to finalize).

5.6 REVIEW MIGRATION MATRIX

5.6.1 Need for a Migration Tracking Mechanism

The original Code Migration Schedule was created after much consideration and coordination of issues, capabilities, needs and likelihood of success. It was approved by CBS and served to provide the basis for planning and coordinating implementation activities.

Code migration was no longer in the planning phase. It had entered the implementation phase. The first Meeting of the Coordination Team for Migration to Table Driven Code Forms (CT/MTDCF) took place at WMO Headquarters in Geneva from 1-4 November 2005. One of the issues discussed was evaluating current status of implementation and the coordination of data exchange. It was agreed the Code Migration Schedule did not reflect the current status and needed updating.

The existing Code Migration Schedule was approved by CBS and contained target-planning dates for start and completion of experimental and operational exchange. This document needed to be kept in place as the general guide for implementation. Now there was a need to track how well the schedule was being met and to record current status.

The Team reviewed the proposed Code Migration Implementation Tracker developed by the Chairman, CT/MTDCF. The Team agreed tracking needed to be done for each TAC code type versus by general categories of codes. The team agreed a "Status" column(s) for each code type was needed which would provide clarification of issues, an indication of how many countries had or hadn't migrated and possibly an indication of who was producing, using or translating TDCFs (BUFR or CREX). The Team realized tracking by individual country could involve considerable work and result in a complex table, but would be very valuable. An option was to have trackers for each region, which would contain individual countries' status, and a master tracker, which would track the status by region. It was also agreed the table would be more manageable in spreadsheet format. These suggestions were being forwarded for consideration by CT/MTDCF.

Some of these suggestions as well as inputs for the tracker entries were included in the tracker version contained in the Annex to this paragraph.

5.6.2 Etienne Charpentier, the representative from IOC, provided updates for BATHY, TESAC and WAVEOB codes for the planned and starting dates for experimental exchange and for the planned starting dates for operational exchange.

5.6.3 William Chillambo, the representative from Tanzania, provided an update on the plans within RA1 for additional training on the use and encoding of data in CREX. He presented forms and instructions, which were developed for recording and encoding data. He indicated that transmission of data in CREX was planned to begin in early 2006 as soon as can be arranged after the training. The Team agreed that more assistance should be provided to countries in Africa like Tanzania. The assistance could be channelled under the auspices of WMO, either by expert mission or training in advanced countries for African staff.

5.6.4 The representative of the Secretariat reported that Countries from West RA I were planning to implement a CREX code for describing squall lines. The project is shown in Annex to this paragraph.

5.7 ADDITIONAL BUFR REQUIREMENTS RELATED TO MIGRATION

The first Meeting of the Coordination Team on Migration to Table Driven Code Forms (CT/MTDCF) took place at WMO Headquarters in Geneva from 1-4 November 2005.

During the meeting a few problems related to BUFR data representation arose, requiring ET/DRC involvement.

The representation of BUFR/CREX tables and their maintenance

There was a clear need for BUFR/CREX tables being represented in more suitable format for computer usage without human intervention. Since the feasibility of representing the tables in XML had been well demonstrated by JMA, the Team recommended that the tables be represented in XML format. The Team recommended that some members of the Team study the problem and provide more detailed contributions, for May 2006 including well-explained sound procedures for efficient implementation.

Representation of NIL reports in BUFR

The CT/MTDCF reviewed the need to represent corrected, amended, delayed and NIL reports. This was 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. The need for quantity monitoring of NIL reports for some data types sets requirements to represent NIL report in BUFR form. The Team recommended that NIL report should be represented by setting all the values in the BUFR subset to "missing value" except for the identification of the station and delayed replications.

Request from ICAO for non-standard units usage in BUFR

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 Team 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 Team had concerned that it might create instabilities in the BUFR messages and Tables. Nevertheless, considering the importance for aviation applications, the Team agreed to allow use of non-standard units as such, provided they were defined in Common Table C-6.

6. DEVELOP GUIDANCE AND PRACTICES FOR THE METEOROLOGICAL INFORMATION REPRESENTATION BASED ON XML AND ON NETCDF

6.1 CREATE XML STANDARDS FOR EXCHANGING METEOROLOGICAL DATA

6.1.1 The Team thanked Stanley Kellet from UKMO for producing a synthetic document on the potential use of XML in meteorology. He presented some views on XML. Current methods of sharing data within WMO were seen by the outside world as being a closed shop. However using Extensible Markup Language, data would be easier to share with the outside community and would allow WMO to set standards in Meteorological XML schemas.
XML was Interoperable:

- Easy to read by machines
- Platform Independent
- ASCII
- Referenced using a URL.

6.1.2 The Team observed that there was a misconception about XML, among some people in the meteorological community. The Team stressed that XML was only a wrapper: XML was a standardized approach for structuring data by framing it with meta-data for purposes such as data exchange, data discovery or enhancing communication protocols. It was important to realize that the relevant meta-data and structure were to be chosen specifically for each application. Even on any given application, individuals working in isolation were likely to produce different and mutually incompatible XML, as has often been the case. Thus, XML was not, on its own, a standard for the representation of meteorological parameters. There was no existing standard, within XML, defining the physical format of the meteorological data to be exchanged. BUFR/CREX/GRIB, which were physical formats, included that feature. For XML, these standards had to be worked out. XML was self-defining, using tags, which described what the data being exchanged were. However, in order that everybody exchanged the same information, one had to describe the physical format of the data with the same agreed tags, which could be recorded in a schema (the equivalent of the BUFR/CREX tables in a certain way). To do this an agreed vocabulary or schema was needed which would allow the processing program to understand the data and the location of the schema could be sent with the XML as a URL, which can be used by anyone in the world with access to the Internet. The self-describing nature was fulfilled by the URL of the schema being sent with the message allowing anyone with Internet access to the schema location, being able to decode the message.

A recommended approach to creating a schema was to start with a domain model, to create UML to describe this and then to encode into XML and then get registered with ISO using ISO191xx.

For example the definition of Geopotential Metadata:

- The UML model is registered as ISO19115
- The XML Schema is registered as ISO19139

6.1.3 When exchanging simple Alpha numeric code forms XML tags were likely to increase the amount of bits being exchanged by a large amount. Gridded data tends to be large and XML has the potential to turn large data files into enormous data files. However, it would be useful to keep an eye on binary XML, which was something on for future developments, as it was still a developing technology.

6.1.4 In conclusion, the Team agreed that XML would allow WMO exchanged data to be more accessible to the wider world community. However, it was certainly not to replace BUFR, which was the most efficient code to exchange the daily 1.5 gigabytes of meteorological observation data between National Meteorological Centres in real time world wide for real time meteorological operational applications. XML would be the answer to the need of some countries to disseminate information with outside users (or for national collection of data or for limited exchange of data between countries). Only for small amount of data, it was feasible to use XML wrapper.

XML was already used for Web application widely. It was indicated that the marine community had developed a standard marine XML. Turkey had developed some XML applications. Canada would use it for the representation of weather forecast. It was used already in several countries for passing some meteorological information, but so far, XML was an envelope that allowed anybody to define their own standards of physical representation.

WMO would need to be involved in setting standards for schemas and methods for exchanging data. So, a set of tasks was to be defined to arrive at the definition of the XML meteorological standards (XML meteorological schema). It had been suggested before that BUFR/CREX Table B be used as a reference for defining parameters in XML, and even CREX parameter characteristics as the tags and visualization standards. It was also recalled that defining meteorological objects was really complicated because there were rules to respect to combine the information.

6.1.5 The Team agreed that it was the role of WMO to define the XML meteorological standard, in order to keep the control of data exchange. However the present ET/DR&C Team had not the expertise to do such work and there was a need to involve the service of a consultant, who should have knowledge of XML as well as of meteorological BUFR/CREX standards. The Team also recommended to carry out a survey towards all WMO Members on the use of XML in the meteorological community, and reiterated strongly the need to organize a workshop where ideas and search for a common approach to defining an XML meteorological schema could emerge.

6.2 CREATE NET CDF STANDARDS FOR EXCHANGING METEOROLOGICAL DATA

6.2.1 As for XML, 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, if not, it would still be anarchy, and they spent a lot of time to adjust their programs to understand the different formats provided by different users. Thus, there was the example of the development of a Climate and Forecast (CF) convention for NetCDF by some universities, laboratory and various agencies.

And their difficulties to deal with that project were mentioned. The WMO Code Groups had been tackling with that problem of standard definition of parameter representation for several decades and had achieved the task with the existing agreed Tables for BUFR, CREX and GRIB.

6.2.2 Because people did not want to follow the WMO GRIB/BUFR/CREX standards (they could not or did not want to learn), the ET/DRC TOR was tasked to help them in a way and to develop guidance and practices for the meteorological information representation based on NetCDF. For example, new conventions were needed to represent meteorological observations in NetCDF (see Annex to this paragraph). So, an enormous task was standing in front the Team. To develop guidance and practices for the meteorological information representation based on XML and NetCDF, definitions of the representation of meteorological observations in those formats were needed.

6.2.3 The Team 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. It was good for climate data, especially global field data. It had unlimited size and could be compressed, but for observations BUFR was still better.

6.2.4 The Team acknowledged its lack of expertise in the field and recommended to hire a consultant to establish the exact requirements, what would be exactly the tasks to put standards for parameters in a convention, how to link it with BUFR/CREX Table B and GRIB, (make inventory of possible conventions to be used, check what was in the conventions), identify what had to be done. There would be a need to establish standard shorter names to BUFR parameters, to be careful with the question of attributes and qualifiers, etc…, and to propose advices on the maintenance of the convention. The consultant should have expertise in NetCDF as well as good knowledge of GRIB 2 and BUFR.

7. LIST OF RESULTANT ACTIONS

2.1.1 All concerned Centres to validate templates for the transmission in GRIB 2 of cross-sections and Hovmöller type diagrams
2.1.2 Team to enquire for Weather Huffman if:(1) some recognized organization accepts to be the official custodian and maintainer of the algorithm and (2) if ICAO provides a commitment that they will actually use it. Then the Team to work with ICAO to undertake validation.
2.1.3 ECMWF: GRIB 2 for GEMS to be refined, to be revisited in May 2006
2.2.3.1 ECMWF: differences between GRIB 1 and GRIB 2, clarify the problem, reconsidered in May 2006.
2.2.3.3 Team: discrepancy in 4.30, octet for instrument type to reconsider in May 2006.
2.2.3.5 ECMWF: to clarify if satisfied with notes for irregular grids.
2.2.3.6 ECMWF to propose a new product definition template or templates with product version number.
2.2.4 ECMWF should examine the data representation templates for JPEG 2000 and PNG compression and propose a proper data representation template for lossless packing of IEEE floating point numbers for consideration in May 2006.
2.3 Centres to advertise their GRIB 2 products.
3.1 Team: descriptors for radiation to be validated before May 2006
3,2 Team: air chemistry descriptors for validation, to be approved in May 2006
3.3 Team: check if SIGMET OK for ICAO, seek pre-operational in May 2006
3.6 1) Secretariat: to finalize common sequence numbers all templates defined for exchange of operational data in BUFR.

3.6 2) Team: validation of new template for buoy directional and non directional wave data seeking pre-operational status in May 2006

3.6 3) Team: new template to represent sub-surface floats to be validated before May 2006.
3.6 4) Secretariat: to refer to GTS expert teams the Test SHIP reports.
3.7: Secretariat: to define system of version number for BUFR.
3.10.7 Team: validation and proper names and number for polar satellite data before May 2006
3.10.8 Team: validation of Table D descriptors for RADOB, TRACKOB, SAREP
3.10.9 Secretariat: to issue corrigendum for substance errors in Manual on Codes
4.1.1 Team: to review the amendments to METAR/SPECI/TAF and put any question to the ICAO secretariat (Mr Neil Hasley), to be re-considered in May 2006
4.1.2 ICAO to respect calendar for implementation of code changes
4.1.3 Secretariat: propose note to be added referring visibility definitions to ICAO Annex 3
4.2 Secretariat: to consult with ICAO for differences in templates.
4,3 Team: more thinking on thunderstorm reporting and possible changes in regulations
4.3 UKMO: to consult ICAO for possible changes in regulations for thunderstorm reporting
5,1,2 Team: to check available reporting practices text in May 2006 and July 2006 (OPAG ISS)
5.2 Team: validation of templates including regional practices.
5.2 Eva Cervena, Jeff Ator, Yves Pelletier: to finalize regional template for RA IV TEMP data.
5.2 Secretariat: Involve regional PIW working groups for validation.
5.3 Team: to review in May 2006 procedural issues for reporting national practices
5.4.1 Secretariat: to update the Web server files with new finalized templates
5.4.2 Team: validation of template for buoy wave data before May 2006
5.4.3 Secretariat and UKMO: to finalize template for May 2006 for high resolution radiosondes
5.5 Charles Sanders, Eva Cervena, ICAO (Neil Halsey, Oli Turpeinen) and Jeff Ator (if more help needed): to finalize METAR/SPECI/TAF BUFR templates for OPAG on ISS in July for approval by CBS.
5.6.1 CT/MTDCF and Secretariat: to fill migration matrix
5.6.3 Secretariat: view how more assistance should be provided to African countries related to the migration
5.7 Team: Study way and propose sound procedures for making available Code tables in XML.
6.1.5 Secretariat: to issue survey to Members on use of XML, to organize workshop on use of XML in meteorology and to hire consultant for definition of meteorological standards in XML
6.2.4 Secretariat: to hire consultant for establishing exact requirements of definition of meteorological standards in NetCDF

8. CLOSURE OF THE MEETING

The Meeting was closed by the Chairman of the ET/DR&C at 19.30 on Thursday 8 December 2005.

ANNEX TO PARAGRAPH 1.1

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ANNEX TO PARAGRAPH 2.2.1

Fire detection.

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

Add:	9, Parameter = Fire detection indicator, Units = Code table (4.223)
Change:	9 – 191, Parameter = Reserved
to:	10 – 191, Parameter = Reserved

In order to define parameter 9 from the modified Code Table 4.2 above, it is also proposed to add a new Code Table, 4.223 as follows:

Code Table 4.223 - Fire detection indicator
- 0 = No fire detected
- 1 = Possible fire detected
- 2 = Probable fire detected
- 3 = Missing

Clear sky reflectance.

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

Add:	Number 6, Parameter = Number of pixels used, Units = numeric
Add:	Number 7, Parameter = Solar zenith angle, Units = degrees
Add:	Number 8, Parameter = Relative azimuth angle, Units = degrees
Add:	Number 9, Parameter = Reflectance in 0.6 micron channel, Units = %
Add:	Number 10, Parameter = Reflectance in 0.8 micron channel, Units = %
Add:	Number 11, Parameter = Reflectance in 1.6 micron channel, Units = %
Add:	Number 12, Parameter = Reflectance in 3.9 micron channel, Units = %
Change:	Number 6 – 191, Parameter = Reserved
to:	Number 13 – 191, Parameter = Reserved

ANNEX TO PARAGRAPH 2.2.2

Table 1.3: Production Status of Data

Number	Meaning
======	======
4	THORPEX Interactive Grand Global Ensemble (TIGGE)
5	THORPEX Interactive Grand Global Ensemble (TIGGE) test

Table 4.2, Discipline 0 – category 1 - moisture

Add:

47- Total column water	kg m^{-2}	Vertically integrated total water (vapour + cloud water/ice)

ANNEX TO PARAGRAPH 2.2.3.2

Amendment needed:

In octet 6-7 of section 1, change Common Code Table reference to C-11:

6-7 Identification of originating/generating centre (see Common Code Table C-11

Common code table C5 – Satellite identifier

An additional column for GRIB edition 2 should be added with 65535 for the missing value and other currently unused entries reserved for future use.

Correction to GRIB edition 2 code table 5.0

52-49151	Reserved
49152-65534	Reserved for local use
65535	Missing

ANNEX TO PARAGRAPH 2.2.3.4

Note to be added at start of template definitions used in sections 5 and 7.

Note: For most templates, details of the packing process are described in regulation 92.9.4

ANNEX TO PARAGRAPH 2.2.5

Add new code table entries in GRIB Edition 1 Code table 4 – Unit of time

Code Table 4

Add:	Number 13, Parameter = quarter of an hour
Add:	Number 14, Parameter = half an hour
Change:	Number 13 – 253, Parameter = Reserved
to	Number 15 – 253, Parameter = Reserved

ANNEX to paragraph 2.2.6

<u>PROPOSAL:</u>

Code Table 1.0: GRIB Master Tables Version Number

0	Experimental
1	Initial operational version number
2	Previous operational version number implemented on 4 November 2003
3	Current operational version number implemented on 2 November 2005
4	Pre-operational to be operational by next amendment
5 -254	Future operational version number
255	Missing value

If the effective date of next amendment to the Code Table 1.0 above is 8 November 2007, the code table would be as follows after the effective date:

Code Table 1.0: GRIB Master Tables Version Number

0	Experimental
1	Initial operational version number
2	Previous operational version number implemented on 4 November 2003
3	Previous operational version number implemented on 2 November 2005
4	Current operational version number implemented on 8 November 2007
5	Pre-operational to be operational by next amendment
6 -254	Future operational version number
255	Missing value

ANNEX to paragraph 2.2.7

Add new parameters as follows:

Code table 4.2, Product discipline 0 - Meteorological products, parameter category 4: short-wave radiation

Number	Parameter	Units
50	UV index *(under clear sky)	Numeric
51	UV index *	Numeric

Add note:

The Global Solar UVI is formulated using the International Commission on Illumination (CIE) reference action spectrum for UV-induced erythema on the human skin (ISO 17166:1999/CIE S 007/E-1998). It is a measure of the UV radiation that is relevant to and defined for a horizontal surface. The UVI is a unitless quantity defined by the formula:

$$I_{UV} = k_{er} \cdot \int_{250\,nm}^{400\,nm} E_{\lambda} \cdot s_{er}(\lambda)\, d\lambda$$

where $\mathbf{E}_{\lambda}$ is the solar spectral irradiance expressed in W·/ (m^2·nanometer) at wavelength λ and **d**λ is the wavelength interval used in the summation. $\mathbf{S}_{er}\,\lambda$ is the erythema reference action spectrum, and $\mathbf{k}_{er}$ is a constant equal to 40 m^2 / W.

ANNEX TO PARAGRAPH 2.2.8

Add a note to Code table 3.11:

Note: For entry 1, it should be noted that depending on values of extreme (first/last) coordinates, and regardless of bit-map, effective number of points per row may be less than the number of points on the current circle.

Duplicate note (3) within Grid Definition Template (GDT) 3.0 should be duplicated for all other GDTs

Note (3) within Grid Definition Template (GDT) 3.0 should be duplicated for all other GDTs which might be associated to quasi-regular grids. It is then recommended to:

- duplicate Note (3) of GDT 3.0 into GDT 3.40
- insert a "pointer" to Note (3) of GDT 3.0 into GDTs 3.[1 to 4]
- do the same to Note (3) of GDT 3.40 into GDTs 3.[41 to 43]

For template GDT 3.0

Also add to Octet list

73-nn List of number of points along each meridian or parallel. These octets are only present for quasi-regular grids as described in notes 2 and 3.

Similar changes are needed for Grid definition templates 3.1, 3.2, 3.3, 3.10, 3.40, 3.41, 3.42, 3.43.

Add entries in Table 4.2, discipline 0, category 1: moisture

- keep current entries in GRIB2, but add a note for entries 9 and 10 stating that all phases are included (provided it is the most used approach)

- add entries for: large-scale water precipitation, convective water precipitation, total water precipitation, total snow precipitation

Add entries:

47	Large scale water precipitation (non-convective)	kg m^{-2}
48	Convective water precipitation	kg m^{-2}
49	Total water precipitation	kg m^{-2}
50	Total snow precipitation	kg m^{-2}
51-191	Reserved	

Add Note: Entries 9 and 10 include all phases of precipitation.

ANNEX TO PARAGRAPH 2.3

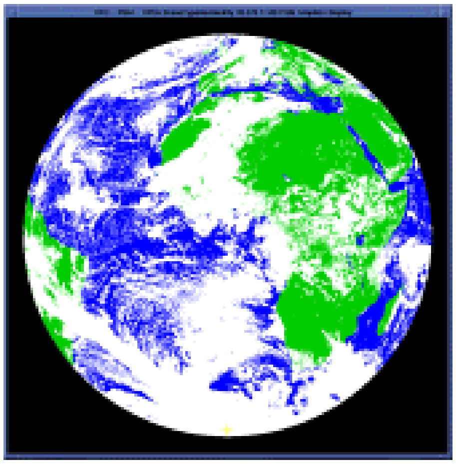
EUMETSAT PRODUCTS AVAILABLE IN GRIB2

- **Cloud Mask (CLM)**

The Cloud Mask is generated for every pixel of the METEOSAT 8 data. The effective resolution is 3 x 3 km at the sub-satellite point. Each pixel is classified as either clear land, clear sea, cloudy or not processed.

The data are disseminated every 15 minutes via the EUMETCast DVB multicast service, and are also available from the EUMETSAT archive.

A typical product is about 3.5 MB. It is encoded without using a bit-map and using simple packing. The image below shows a typical product.

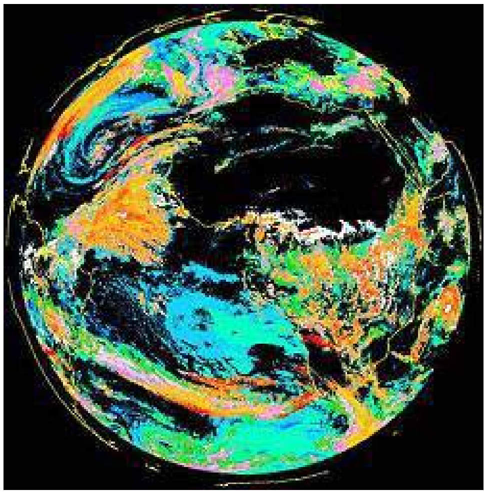


- **Cloud Top Height (CTH)**

The Cloud Top Height is generated for each 3 x 3 super-pixel of the METEOSAT 8 data. The effective resolution is 9 x 9 km at the sub-satellite point. Each super-pixel assigned a height and has information attached about its quality and the presence of fog.

The data are disseminated every 60 minutes via the EUMETCast DVB multicast service, and are also available from the EUMETSAT archive.

A typical product is about 800 kB. It is encoded using a bit-map and simple packing. The image below shows a typical product.

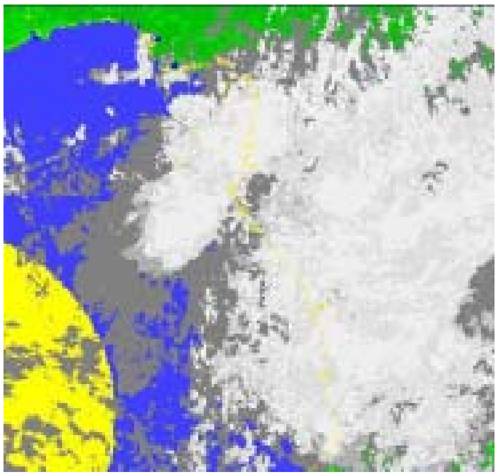


- **Cloud Analysis Image (CLAI)**

The Cloud Analysis Image is generated for each 3 x 3 super-pixel of the METEOSAT 8 data. The effective resolution is 9 x 9 km at the sub-satellite point. Each super-pixel assigned a value to indicate the type of scene seen in the pixel. This can be one of a number of surface or cloud types.

The data are disseminated every 3 hours via the EUMETCast DVB multicast service, and are also available from the EUMETSAT archive.

A typical product is about 1.2 MB. It is encoded without using a bit-map and using simple packing. The image below shows a section of a typical product over the West African coast.

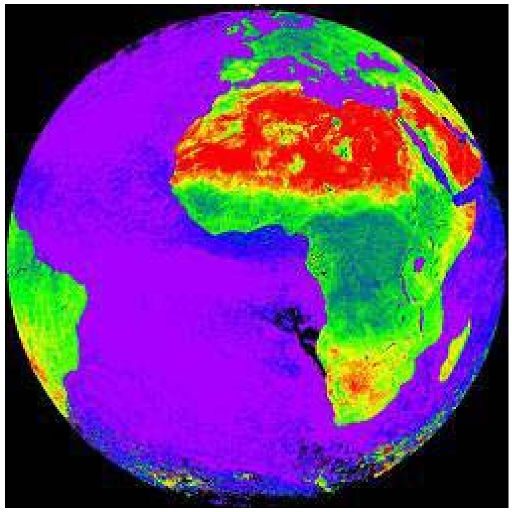


- **Clear Sky Reflectance Map (CRM)**

The Clear Sky Reflectance Map is generated for every pixel of the METEOSAT 8 data. The effective resolution is 3 x 3 km at the sub-satellite point. For each the product contains information about the number of images used in the derivation, the relevant angles, and the reflectance in the 0.6, 0.9, 1.6 and 3.9 micron channels.

The data are disseminated twice each week via the EUMETCast DVB multicast service, and are also available from the EUMETSAT archive.

A typical product is about 20 MB. It is encoded without a bit-map and using complex packing. The encoding is performed using the NCEP software from the Internet. The image below shows a typical product.

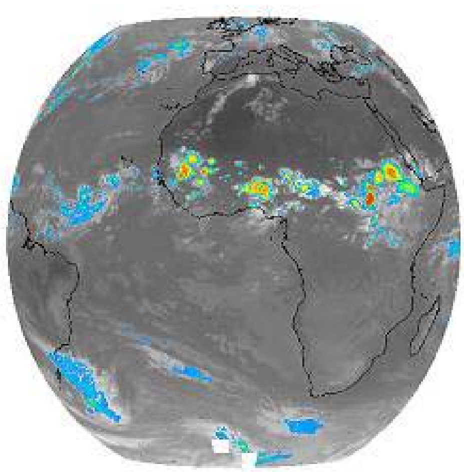


- **Multi Sensor Precipitation Estimate (MPE)**

The Multi Sensor Precipitation Estimate is generated for METEOSAT 5 and METEOSAT 7 data, and also uses SSMI data. The effective resolution is 5 x 5 km at the sub-satellite point. Each pixel is assigned a rain rate.

The data are available every 30 minutes via download from EUMETSAT's web site, http://www.eumetsat.int. The data can be found by selecting Home > Image Gallery > Derived Product Imagery, and clicking on the thumb nail image of MPE. This brings up a browser for displaying and animating MPE data. By selecting the link to "Product Generation and Interpretation page" it is possible to bring up a further page with details of some imagery data. At the extreme bottom of this page is a link labeller "GRIB2 data", which takes the user to a site where the MPE data from both satellites for the last 24 hours can be downloaded.

A typical product is about 800 KB. It is encoded using a bit-map and simple packing. The image below shows a typical product.



- **Fire Detection Product (FIR)**

The Fire Detection Product is generated for every pixel of the METEOSAT 8 data. The effective resolution is 3 x 3 km at the sub-satellite point. Each pixel is classified as either not on fire, possibly on fire, probably on fire or not processed.

The fire detection products are generated every 15 minutes and are freely available. They can be downloaded as follows:

host	ftp.eumetsat.int
login	anonymous
password	<your@email.adderss>
path	/pub/OPS/out/simon/FIRE

A typical product is about 20 KB. It is encoded using complex packing. The encoding is performed using the NCEP software from the Internet.

ANNEX TO PARAPH 3.1

NEW ALLOCATED BUFR/CREX ENTRIES (AWAITING VALIDATION)

ADDITIONS FOR REPORTING BOTH NOMINAL AND INSTRUMENT VALUES IN BUFR TEMPLATES FOR SURFACE OBSERVATION DATA

A new descriptor in the Class 8 is proposed as a nominal value indicator (for Level II data):

0 08 083 Nominal value indicator, Flag table, 0, 0, 15

Bit No.	
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

Two new descriptors in Class 7 are proposed

F X Y	Element name	BUFR				CREX		
0 07 065	Representative height of sensor above local ground (or deck of marine platform)	m	2	0	16	m	2	5

Note: Representative height of sensor above local ground (or deck of marine platform) is the standard height of a sensor required by WMO documentation. Value of the following meteorological element should be adjusted using a formula (or a recommended procedure for obtaining nominal values). For example, standard height recommended in WMO documentation for surface wind sensors is 10 m. If the sensor is placed at different height, the wind speed should be adjusted using a formula.

F X Y	Element name	BUFR				CREX		
0 07 066	Representative height of sensor above water surface	m	1	0	12	m	1	4

Note: Representative height of sensor above water surface is the standard height of a sensor required by WMO documentation. Value of the following meteorological element should be adjusted using a formula (or a recommended procedure for obtaining nominal values).

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).

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) **D_s**	Degree true, 0
		0 01 013	Speed of motion of moving observing platform(4) **v_s**	m s^{-1}, 0
		0 02 001	Type of station **(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) **$L_aL_aL_a$**	Degree, 2
		0 06 002	Longitude (coarse accuracy) **$L_oL_oL_oL_o$**	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	0 02 038	Method of sea surface temperature measurement	Code table, 0
		0 22 043	Sea/water temperature **$s_sT_wT_wT_w$**	K, 2
			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 (for temperature measurement)	m, 1
		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
			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 910$\mathbf{f_m f_m}$, 911$\mathbf{f_x f_x}$	$m s^{-1}$, 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.

ENTRIES DECLARED PRE-OPERATIONAL

0 08 080 - Qualifier for GTSPP quality class

New Code figure

5-9 *Reserved*
10 **Water pressure at a level**
11 **Water temperature at a level**
12 **Salinity at a level**
13-19 *Reserved*
20 **Position**
21-62 *Reserved*

New table entries to describe profiling float identifier and vertical coordinate below sea/water surface in pressure are necessary as follows.

Table reference	Table element name	Unit	Scale	Ref.	Data width
001087	**WMO Marine observing platform extended identifier**	Numeric	0	0	23
007065	**Water pressure**	Pa	-3	0	17

ADD THE FOLLOWING TABLE B ENTRY FOR NUMERICAL MODEL IDENTIFIER :

0 01 030 Numerical model identifier, CCITTIA5, Scale=0, Reference=0,Data bit width=128

Note: The value of this feature could be a string of characters, which contains the name of the model and other useful elements such as the model mesh.

NEW DESCRIPTORS NEEDED FOR DATA REPRESENTATION OF SYNOP DATA

F X Y	Element name	BUFR				CREX		
0 12 049	Temperature change over specified period	K	0	-30	6	°C	0	2
0 20 054	True direction from which clouds are moving	Degree true	0	0	9	Degree true	0	3

SEQUENCE DESCRIPTORS FOR SYNOPTIC REPORTS FROM LAND AND SEA STATIONS (SUITABLE FOR SYNOP, SYNOP MOBIL AND SHIP OBSERVATION DATA)

1. List of sequence descriptors displayed in the templates

The following sequence descriptors for synoptic reports from land and ship (suitable for SYNOP, SYNOP MOBIL and SHIP observations data) are listed below within the Templates in paragraph 3.

3 01 090, 3 01 092, 3 01 093, 3 02 031, 3 02 032, 3 02 033, 3 02 034, 3 02 035, 3 02 036, 3 02 037, 3 02 038, 3 02 039, 3 02 040, 3 02 041, 3 02 042, 3 02 043, 3 02 044, 3 02 045, 3 02 046, 3 02 047, 3 02 048, 3 02 052, 3 02 053, 3 02 054, 3 02 055, 3 02 056, 3 02 057, 3 02 058, 3 02 059, 3 02 060, 3 07 080, 3 07 090 and 3 08 007.

2. Sequence descriptors 3 02 046, 3 02 047 and 3 02 048

3 02 046 is proposed to express the data of the SYNOP group $54g_0s_nd_T$, where

g_0 is "Period of time, in hours, between the time of observation and the temperature change",
s_n is "Sign of the temperature change" – Code table 3845,
d_T is " Amount of temperature change, the sign of the change given by s_n "– Code table 0822.

		(Temperature change)
3 02 046	0 04 024	Time period or displacement
	0 04 024	Time period or displacement
	0 12 049	Temperature change over period specified

3 02 047 is proposed to express data of SYNOP group $56D_LD_MD_H$, where

D_L is "True direction from which C_L clouds are moving" – Code table 0700,
D_M is "True direction from which C_M clouds are moving" – Code table 0700,
D_H is "True direction from which C_H clouds are moving" – Code table 0700.

		(Direction of cloud drift)
3 02 047	1 02 003	Replicate 2 descriptors 3 times
	0 08 002	Vertical significance
	0 20 054	True direction from which clouds are moving

3 02 048 is proposed to express data of SYNOP group 57CD$_a$e$_C$, where

C is "Genus of cloud" – Code table 0500,

D$_a$ is "True direction in which the phenomenon indicated is observed" – Code table 0700,

e$_C$ is "Elevation angle of the top of the cloud indicated by C" – Code table 1004.

		(Direction and elevation of cloud)
3 02 048	0 05 021	Bearing or azimuth
	0 07 021	Elevation angle
	0 20 012	Cloud type
	0 05 021	Bearing or azimuth (= missing to cancel the previous value)
	0 07 021	Elevation angle (= missing to cancel the previous value)

3.1 BUFR template for synoptic reports from fixed land stations suitable for SYNOP observation data

During the recent validation process a typo has been corrected within 3 02 043 (Basic synoptic "period" data) as marked below. 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).
It is proposed to represent this template by a single descriptor 3 07 080.

3 07 080:

3 01 090			**Fixed surface station identification, time, horizontal and vertical coordinates**	Unit, scale
	3 01 004	0 01 001	WMO block number **II**	Numeric, 0
		0 01 002	WMO station number **iii**	Numeric, 0
		0 01 015	Station or site name	CCITT IA5, 0
		0 02 001	Type of station (i_x)	Code table, 0
	3 01 011	0 04 001	Year	Year, 0
		0 04 002	Month	Month, 0
		0 04 003	Day **YY**	Day, 0
	3 01 012	0 04 004	Hour **GG**	Hour, 0
		0 04 005	Minute **gg**	Minute, 0
	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
3 02 031			**Pressure data**	
	3 02 001	0 10 004	Pressure $\mathbf{P_0P_0P_0P_0}$	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
	0 10 062		24-hour pressure change $\mathbf{p_{24}p_{24}p_{24}}$	Pa, –1

	0 07 004		Pressure (standard level) **a_3**	Pa, –1
	0 10 009		Geopotential height of the standard level **hhh**	gpm, 0
3 02 035			**Basic synoptic "instantaneous" data**	
	3 02 032		**Temperature and humidity data**	
		0 07 032	Height of sensor above local ground (for temperature measurement)	m, 2
		0 12 101	Temperature/dry-bulb temperature(sc.2) **s_nTTT**	K, 2
		0 12 103	Dew-point temperature (scale 2) **$s_nT_dT_dT_d$**	K, 2
		0 13 003	Relative humidity	%, 0
	3 02 033		**Visibility data**	
		0 07 032	Height of sensor above local ground (for visibility measurement)	m, 2
		0 20 001	Horizontal visibility **VV**	m, –1
	3 02 034		**Precipitation past 24 hours**	
		0 07 032	Height of sensor above local ground (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 local ground (set to missing to cancel the previous value)	m, 2
			Cloud data	
	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
3 02 036			**Clouds with bases below station level**	
	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'H'**	m, -1
	0 20 017		Cloud top description **C_t**	Code table, 0
3 02 047			**Direction of cloud drift** gr. **$56D_LD_MD_H$**	
	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
3 02 048			**Direction and elevation of cloud** gr. **$57CD_ae_C$**	

	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 02 037			**State of ground, snow depth, ground minimum temperature**	
	0 20 062		State of ground (with or without snow) **E** or **E'**	Code table, 0
	0 13 013		Total snow depth **sss**	m, 2
	0 12 113		Ground minimum temperature (scale2), past 12 hours **$s_nT_gT_g$**	K, 2
3 02 043			**Basic synoptic "period" data**	
	3 02 038		**Present and past weather**	
		0 20 003	Present weather **ww** or **w_aw_a**	Code table, 0
		0 04 024	Time period in hours	Hour, 0
		0 20 004	Past weather (1) **W_1** or **W_{a1}**	Code table, 0
		0 20 005	Past weather (2) **W_2** or **W_{a2}**	Code table, 0
			Sunshine data (from 1 hour and 24 hour period)	
	1 01 002		Replicate 1 descriptor 2 times	
	3 02 039	0 04 024	Time period in hours	Hour, 0
		0 14 031	Total sunshine **SS** and **SSS**	Minute, 0
	3 02 040		**Precipitation measurement**	
		0 07 032	Height of sensor above local ground (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
	3 02 041		**Extreme temperature data**	
		0 07 032	Height of sensor above local ground (for temperature measurement)	m, 2
		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
	3 02 042		**Wind data**	
		0 07 032	Height of sensor above local ground (for wind measurement)	m, 2
		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 03 002	Replicate next 3 descriptors 2 times	
		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
	0 07 032		Height of sensor above local ground (set to missing to cancel the previous value)	m, 2
3 02 044			**Evaporation data**	
	0 04 024		Time period in hours	Hour, 0
	0 02 004		Type of instrument for evaporation or crop type for evapotranspiration i_E	Code table, 0
	0 13 033		Evaporation /evapotranspiration **EEE**	kg m^{-2}, 1
			Radiation data (from 1 hour and 24 hour period)	
1 01 002			Replicate next descriptor 2 times	
3 02 045	0 04 024		Time period in hours	Hour, 0
	0 14 002		Long-wave radiation, integrated over period specified 553SS 4**FFFF** or 553SS 5**FFFF,** 55SSS 4$F_{24}F_{24}F_{24}F_{24}$ or 55SSS 5$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -3
	0 14 004		Short-wave radiation, integrated over period specified 553SS 6**FFFF,** 55SSS 6$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -3
	0 14 016		Net radiation, integrated over period specified 553SS 0**FFFF** or 553SS 1**FFFF,** 55SSS 0$F_{24}F_{24}F_{24}F_{24}$ or 55SSS 1$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
	0 14 028		Global solar radiation (high accuracy), integrated over period specified 553SS 2**FFFF,** 55SSS 2$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
	0 14 029		Diffuse solar radiation (high accuracy), integrated over period specified 553SS 3**FFFF,** 55SSS 3$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
	0 14 030		Direct solar radiation (high accuracy), integrated over period specified 55408 4**FFFF,** 55508 5$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
3 02 046			**Temperature change** group **54$g_0s_nd_T$**	
	0 04 024		Time period or displacement	Hour, 0
	0 04 024		Time period or displacement (see Note 3)	Hour, 0
	0 12 049		Temperature change over period specified **s_nd_T**	K, 0

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

3.2 BUFR template for synoptic reports from mobile land stations suitable for SYNOP MOBIL observation data

BUFR template for SYNOP MOBIL is similar to the BUFR template for SYNOP. The only difference between them is in the very first sequence descriptor; in case of representation of SYNOP MOBIL data, the station identification, time, horizontal and vertical coordinates is provided by a sequence descriptor **3 01 092** (not yet been included in Manual on Codes, WMO-No. 306, I.2 (November 2005)).

It is proposed to represent this template by a single descriptor **3 07 090**.

3 07 090:

3 01 092			**Mobile surface station identification, time, horizontal and vertical coordinates**	Unit, scale
	0 01 011		Mobile land station identifier **D….D**	CCITT IA5, 0
	0 01 003		WMO Region number $\mathbf{A_1}$	Code table, 0
	0 02 001		Type of station ($\mathbf{i_x}$)	Code table, 0
	3 01 011	0 04 001	Year	Year, 0
		0 04 002	Month	Month, 0
		0 04 003	Day **YY**	Day, 0
	3 01 012	0 04 004	Hour **GG**	Hour, 0
		0 04 005	Minute **gg**	Minute, 0
	3 01 021	0 05 001	Latitude (high accuracy) $\mathbf{L_aL_aL_a}$	Degree, 5
		0 06 001	Longitude (high accuracy) $\mathbf{L_oL_oL_oL_o}$	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 33 024		Station elevation quality mark $\mathbf{i_m}$	Code table, 0

The rest of the template is identical with the BUFR template for SYNOP data, including the Notes below the template for SYNOP data.

3.3 BUFR template for synoptic reports from sea stations suitable for SHIP observation data

Editorial modification has been done within 3 02 052 (Temperature and humidity data) as marked below. 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).

It is proposed to represent this template by a single descriptor **3 08 007**.

3 08 007:

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) **$L_aL_aL_a$**	Degree, 2
		0 06 002	Longitude (coarse accuracy) **$L_oL_oL_oL_o$**	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
			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
3 02 054			**SHIP "instantaneous" data**	
			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	
	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	
	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	
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
3 02 057			**SHIP marine data**	
			Sea/water temperature	
	3 02 056	0 02 038	Method of sea surface temperature measurement	Code table, 0
		0 22 043	Sea/water temperature **$s_sT_wT_wT_w$**	K, 2
			Waves	
	3 02 021	0 22 001	Direction of waves	Degree true
		0 22 011	Period of waves **$P_{wa}P_{wa}$**	s, 0
		0 22 021	Height of waves **$H_{wa}H_{wa}$**	m, 1
	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 02 060			**SHIP"period" data**	
			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	
	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	
	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 (for temperature measurement)	m, 1
		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
			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 02 059	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 03 002	Replicate next 3 descriptors 2 times	
		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 3.2

Example descriptor sequence

Full templates for specific instances of Air Quality observations are not provide; however, the general structure of a descriptor sequence is envisioned as follows (where indentation indicates repeatable sub-sequences of descriptors):

I. Identification of measurement site and instrumentation

II. Date/time of start of measurement

- *a) Horizontal and vertical coordinates of measurement site*
- *b) Time displacement from start of measurement (high precision)*
- *c) Lat/lon displacement from start of measurement (high precision)*
- *d) Vertical coordinate value (using high-precision descriptor when required)*
- *e) Atmospheric constituent type (new descriptor 0 08 043 or 0 08 044)*
- *f) 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 measurements taken by balloon or aircraft. Appropriate templates would have to be designed for ground-based and satellite measurements.

Design issues

Catalog of chemical species: Atmospheric chemistry potentially deals with thousands of molecules. While an initial list may have "only" contained a few dozen species, we perceive that it is important to formulate an approach that scales well as the number of measured chemicals grows. Unless well planned from the outset, this could become a significant maintenance issue and involve us in an area (the cataloging of chemicals) that we may not want to get into.

We propose to address the issue as follows:

In chemistry, unambiguous identification of a chemical is commonly accomplished through the use of so-called CAS Registry Numbers. CAS (Chemical Abstracts Service, http://www.cas.org/EO/regsys.html) is a division of the American Chemical Society. A CAS number is composed of 11 characters at most: 9 digits or less, and 2 hyphens.

We propose the creation of a BUFR table B descriptor that would allow the use of CAS numbers inside a BUFR message. This would have at least three advantages:

- allowing the use of CAS numbers would alleviate the need to create and maintain tables of atmospheric chemicals within the BUFR framework (but not quite eliminate it). However, those tables that we would have to create, could then be short and generic.
- CAS would provide a more robust catalog than what we could come up with on our own
- It would connect the BUFR representation of atmospheric chemistry with a tool that is well known and routinely used by chemists.

The downside of this, is that a chemical designated by its CAS Registry Number must then be looked up in the CAS database or some other source, such as could be found in the scientific litterature. We believe this is easily manageable by users in the field of Atmospheric Chemistry. Thus, for completely unambiguous specification of chemical species in BUFR, the use of CAS registry numbers would be recommended.

A small WMO-maintained catalog would still be required, but only for general and generic species without a CAS number, such as volcanic ash, smoke, and generic aerosols. Very fundamental species such as water vapour, ozone and the other main greenhouse gases would also be included. The catalog would take the form of a code table corresponding to proposed element descriptor 0 08 043 (see below). To prevent undue growth of the WMO maintained catalog, the addition, to this table, of constituents endowed with a CAS number should be given careful consideration and occur only for especially common or important species.

A short discussion of the main chemicals of interest is included in Annex B.

Precision requirements and bit length of descriptors: The absolute values and precision required for some measurement types (i.e. concentration) span across at least 16 decimal orders of magnitude. Individual chemical species may have narrower requirements, but to accommodate a whole catalog of species with a single concentration descriptor, that is what we need. 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.

Within the existing BUFR framework, the chosen solution was to give the concentration (and similar) descriptors default scales and bit width that work for the greater number of species, and to leave specialist users to choose appropriate scaling and bit width on a case by case basis, by using BUFR Data Description Operators.

As a means of providing additional flexibility, we also propose to create a new Data Description Operator that would make it possible to express values in IEEE floating-point format. In many cases this would allow data representation with the fewest possible intermediate steps while maintaining sufficient precision. It would, however, require the adaptation of existing decoders. We believe this would be worth the work, since the added flexibility could have benefits in other areas that demand the depiction of extremely large value ranges.

Proposed new descriptors for atmospheric constituents

(1) Measured or physical quantities

Table Reference	Element name	BUFR				CREX		
F X Y		Unit	Scale	Ref. value	Data width (bits)	Unit	Scale	Data width (chars)
0 15 007	Molecular mass	u (unified atomic mass unit)	2	0	15	U (unified atomic mass unit)	2	5
0 15 008	Volumetric mixing ratio	numeric	16	0	31	numeric	16	10
0 15 009	Integrated number density	m^{-2}	-12	0	31	m^{-2}	-12	10

0 15 010	Partial pressure	Pa	12	0	31	Pa	12	10
0 15 021	Integrated mass density	kg/m^2	14	0	31	Kg/m^2	14	10
0 15 022	Number density	m^{-3}	-8	0	31	m^{-3}	-8	10
0 15 023	Mass density	kg/m^3	18	0	31	kg/m^3	18	10
0 15 024	Optical depth	numeric	4	0	24	numeric	4	8
0 15 029	Extinction coefficient	m^{-1}	9	0	30	m^{-1}	9	10
0 15 028	Photo dissociation rate	s^{-1}	14	0	31	s^{-1}	14	10

(2) Coordinates

Table Reference	Element name	BUFR				CREX		
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	**Unit**	**Scale**	**Data width (chars)**
0 07 011	Pressure (high precision)	Pa	4	0	31	Pa	4	10

(3) Processing information

Table Reference	Element name	BUF				CREX		
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	**Unit**	**Scale**	**Data width (chars)**
0 02 071	Spectrographic wavelength	m	13	0	30	m	13	10
0 02 072	Spectrographic width	m	13	0	30	m	13	10

(4) Significance qualifier

Table Reference	Element name	BUFR				CREX		
F X Y		**Unit**	**Scal e**	**Ref. value**	**Data width (bits)**	**Unit**	**Scale**	**Data width (chars)**
0 08 043	Atmospheric chemical or physical constituent type	Code Table	0	0	8	Code table	0	3
0 08 044	CAS registry number	Numeric	0	0	30	Numeric	0	10

Code table 0 08 043

See remarks in section "Design Issues", sub-section 1, and in Appendix B.
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
04-24	reserved		
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		

Data description operator

An already existing method of dealing with very large numerical ranges, used in satellite BUFR messages, will be incorporated in the proposal. The method uses descriptors to specify explicitly the scale factor and data width. It is still believed that adding the option of IEEE representation is desirable; but the existing method is tested and proven.

Table Reference	*Operator name*	*Operation Description*
F X Operand		
2 07 YYY	*IEEE floating point representation*	*For elements in Table B other than CCITT IA5, code tables or flag tables, this operator shall indicate that values are represented in YYY bit IEEE floating point, where YYY can be set to 032, 064 or any valid IEEE floating point width. This operator shall override the scaling and bit width from Table B. The reference value from Table B may be used for bound-checking if applicable. An operand of YYY=000 shall reinstate the Table B scaling and bit width.*

Appendix A - Range correspondence

Determination and identification of the minimum and maximum values corresponding to the definitions of the descriptor elements in tables 1 to 3 are presented here. Two maxima are provided when the range of possible expected values cannot be expressed with at most 31 bits; a maximum of at most 2×10^9 larger than the minimum value can be obtained from 31 bits. In such instances, both the magnitude corresponding to a limit of 31 bits, in consideration of the minimum value in the table, and the magnitude of the largest expected value are provided.

The range of values for concentrations of constituent observations is based on a minimum set according to a minimum OH mixing ratio of $\sim10^{-14}$ with a precision of 1% and the largest expected maximum set according to the upper limit for tropospheric H_2O mixing ratio at ~0.04. The next largest mixing ratios would be attributed to CO_2 at a level just under 0.001. For conversion to other units which involve pressure and/or temperature, pressures of 10^5 Pa and 10^4 Pa for the calculation of the maxima and minima and a temperature of 300 were applied. Use of 10^4 Pa with the OH mixing ratio is reasonable for determination of the minimum considering the increase in OH mixing ratio with decreasing pressure as well as the larger mixing ratios in the stratosphere and mesosphere for other constituents. Here are the conversions applied to the volumetric mixing ratios followed by the resulting ranges:

Parameter	**Unit**	**Conversion factor from mixing ratio**
Pressure	Pascal	P_{air}
Number density	m^{-3}	$P_{air}N_a /(R^*T)$
Mass density	kg/m^3	$P_{air}M /(R^*T)\ \times10^{-3}$ kg/g
Integrated number density	m^{-2}	$HP_{air}N_a /(R^*T)$
Integrated mass density	kg/m^2	$HP_{air}M /(R^*T)\ \times10^{-3}$ kg/g

where P_{air} is the atmospheric pressure in Pa, N_a is the Avogradro constant (6.022×10^{23} /mol), R* is the gas constant (8.314 J K^{-1} mol^{-1}), T is temperature in Kelvin, H is the scale height of the atmosphere set to $7x10^3$ m, and M is the molecular mass in unified mass units u (i.e., g mol^{-1}), hence the additional conversion factor of 10^{-3} kg/g.

Table Reference F X Y	Element name	Unit	Minimum value	Maxima: Based on a limit of 31 bits	Maxima: Largest expected value
0 15 007	Molecular mass	u (unified mass unit)	0.01	-	327.67
0 15 008	Mixing ratio in volume	numeric	10^{-16}	$2x10^{-7}$	0.04
0 15 009	Integrated number density	m^{-2}	10^{12}	$2x10^{21}$	10^{28}
0 15 010	Partial pressure	Pa	10^{-12}	$2x10^{-3}$	10^4
0 15 021	Integrated mass density	kg/m^2	10^{-14}	$2x10^{-5}$	10^2
0 15 022	Number density	m^{-3}	10^8	$2x10^{17}$	10^{24}
0 15 023	Mass density	kg/m^3	10^{-18}	$2x10^{-9}$	10^{-2}
0 15 024	Optical depth	numeric	0.0001	-	1000 (clouds)
0 15 029	Extinction coefficient	m^{-1}	10^{-9}	-	1.0 (clouds)
0 15 028	Photo dissociation rate	s^{-1}	10^{-14}	$2x10^{-5}$	0.1
0 07 011	Pressure (high precision	Pa	10^{-4} [0.1 Pa (~95 km) with 4 significant digits]	-	$2x10^5$
0 25 103	Spectral width (line widths to band models)	m	10^{-13}	-	10^{-4}
0 25 102	Wavelength	m	10^{-13} (10^2 nm with 7 significant digits)	-	10^{-4} (10^2 μm)

Appendix B - Chemicals of Interest

We provide below a list of chemicals of interest not present in Code Table 0 08 043, with their CAS registry numbers. In BUFR code, these chemicals would be identified by their CAS numbers, using element descriptor 0 08 044. Maintenance of this list is not viewed as being within the scope of the Expert Team on Data Representation and Codes; it is only provided here for illustration purposes.

A first iteration of the list was based on Tables 4.1-4.3 and the text of the IGACO theme report of September 2004 (WMO TD No. 1235)).

Three halon compounds were included based on the table of class I ozone-depleting substances (Group II) of the U.S. Environmental Protection Agency (http://www.epa.gov/docs/ozone/ods.html). CFC-11 was added to complement CFC-12 and HCFC-22 of the IGACO report.
The list of measured volatile organic compounds (VOC) would be quite extensive and is not explicitly identified here. A list of VOC and related families can be consulted in Makar et al. (JGR, **108**, 2003).
Other species such as OH, HNO_4, CCl_4, NH_3, CF_4, H_2O_2, N_2O_5, HF, H_2SO_4, OCS, HOCl, PAN, O (^{1}D) and mercury-related compounds could also be considered.

Name	Formula	CAS registry number
Carbon monoxide	CO	630-08-0
Nitrogen dioxide	NO_2	10102-44-0
Nitrous oxide	N_2O	10024-97-2
Bromine oxide	BrO	15656-19-6
Chlorine monoxide	ClO	7791-21-1
Hydrogen chloride	HCl	7647-01-0
Chlorine dioxide	OClO	10049-04-4
Trichlorofluoromethane	CFC-11 (CCl_3F)	75-69-4
Dichlorodifluoromethane	CFC-12 (CCl_2F_2)	75-71-8
Nitric Oxide	NO	10102-43-9
Nitric acid	HNO_3	52583-42-3
Acetylene	C_2H_2	74-86-2
Ethane	C_2H_6	74-84-0
Methyl bromide	CH_3Br	74-83-9

Name	Formula	CAS registry number
Bromotrifluoro-methane	CF_3Br (halon 1301)	75-63-8
Bromochloro- difluoromethane	CF_2ClBr (halon 1211)	353-59-3
Dibromotetra-fluoroethane	$C_2F_4Br_2$ (halon 2402)	25497-30-7
Chlorodifluoro-methane	HCFC-22 ($CHClF_2$)	75-45-6
Chlorine nitrate	$ClONO_2$	14545-72-3
Formaldehyde	HCHO	50-00-0
Sulfur dioxide	SO_2	7446-09-5

IN RELATION TO PARAGRAPH 3.9:

Proposal by Martin Suttle (ECMWF)

Comments on the proposal by the Team:

a. Spectrographic wavelength descriptor from the proposal above is to be used to qualify optical depth, instead of carrying physical measurement and wavelength in same descriptor (remove 0 15 040 and rename 0 15 041)
b. Similarly, “error” descriptors are to use first order statistics from class 08
c. Meaning of “small mode” to be clarified (0 15 041). If necessary, a new entry in First Order Statistics Code Table will be proposed.
d. It may be a little premature yet to create averaging kernel descriptors (*linked to statistics*). We need the research community to reach consensus and then to express representation requirements. (0 15 044)
e. The version of Code Table 0 08 043 contained in this proposal should be used, as it is a superset of the version proposed in document 3.2(1); **however**, the proposed table elements “Maritime”, “Continental”, and “Sulfate” were refused as they are qualifiers and not physical or chemical constituents.

Key: xxxx **element from proposal of Pelletier and Rochon**
yyyy **new element needed**

Aerosol

Table Reference	Parameter	Units
0 01 007	Satellite identifier	
0 02 019	Satellite instrument	
0 01 033	Identification of originating/generating centre	
0 02 172	Product type for retrieved atmospheric gases	
0 04 001	Year	year
0 04 002	Month	month
0 04 003	Day	day
0 04 004	Hour	hour
0 04 005	Minute	minute
0 04 006	Second	second
0 05 001	Latitude (high accuracy)	degree
0 06 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 07 025	Solar zenith angle	degree
0 07 024	Satellite zenith angle	degree
	Solar azimuth angle	degree
	Satellite azimuth angle	degree
	Cloud mask and snow/ice indicator	Flag Table
	Cloud amount percentage interval	Code Table
0 08 013	Day/night qualifier	Code Table
0 08 065	Sun-glint indicator	Code Table
0 05 043	Field of view number	numeric
0 20 010	Cloud cover (total)	%
0 20 016	Pressure at top of cloud	Pa
0 13 040	Surface flag (with proposed addition - see below)	Code Table
0 33 003	Quality information	
0 08 043	Atmospheric chemical or physical constituent type	Code Table
	Aerosol optical depth at 0.55 micron	numeric
	Error in aerosol optical depth at 0.55 micron (see Note 2)	numeric
	Ratio of small mode aerosol optical depth at 0.55 micron	numeric
	Error in ratio of small mode aerosol optical depth at 0.55 micron (see Note 2)	numeric
0 22 094	Number of wavelength bands	numeric
	Per wavelength band	
0 25 102	Spectrographic wavelength	m
	Reflectance	numeric

	Error reflectance (see Note 2)	numeric
0 10 040	Number of retrieved layers (for optical depth)	numeric
	Per optical depth layer	
0 07 004	Layer top pressure	Pa
0 07 004	Layer bottom pressure	Pa
0 15 024	Optical depth	numeric
	Error optical depth (see Note 2)	numeric
0 10 040	Number of retrieved layers (for extinction)	numeric
	Per extinction layer	
0 07 004	Layer top pressure	Pa
0 07 004	Layer bottom pressure	Pa
0 15 029	Extinction coefficient	m^{-1}
	Error extinction coefficient (see Note 2)	m^{-1}

Chemical species

Initial GEMS chemical species are:

- O_3 (ozone)
- NO_2 (nitrogen dioxide)
- SO_2 (sulphur dioxide)
- HCHO (formaldehyde)
- CO_2 (carbon dioxide)
- N_2O (nitrous oxide)
- CO (carbon monoxide)
- CH_4 (methane)

Table Reference	Parameter	Units
0 01 007	Satellite identifier	
0 02 019	Satellite instrument	
0 01 033	Identification of originating/generating centre	
0 02 172	Product type for retrieved atmospheric gases	
0 04 001	Year	year
0 04 002	Month	month
0 04 003	Day	day
0 04 004	Hour	hour
0 04 005	Minute	minute
0 04 006	Second	second
0 05 001	Latitude (high accuracy)	degree
0 06 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 27 001	Latitude (high accuracy)	degree
0 28 001	Longitude (high accuracy)	degree
0 07 022	Solar elevation	degree

0 05 043	Field of view number	numeric
0 20 010	Cloud cover (total)	%
0 20 016	Pressure at top of cloud	Pa
0 08 012	Land/sea mask	numeric
0 33 003	Quality information	
0 08 043	Atmospheric chemical or physical constituent type (see Note 1)	Code Table
0 10 040	Number of retrieved layers	numeric
	Per retrieved layer	
0 07 004	Layer top pressure	Pa
0 07 004	Layer bottom pressure	Pa
0 15 021	Integrated mass density	kg/m^2
	Error integrated mass density (see Note 2)	kg/m^2
	No. of averaging kernel layers	numeric
	Per averaging kernel layer	
0 07 004	Layer top pressure	Pa
0 07 004	Layer bottom pressure	Pa
	Averaging kernel value	numeric

Notes:

1. Need CO, NO_2, N_2O, HCHO and SO_2 include in proposed Code Table 0 08 043.

2. We will have to be clear on what "error" means, i.e. could be 1-σ, 3- σ, rms, etc.

New BUFR descriptors for GEMS observational data

Table Reference	Element Name	BUFR				CREX		
F X Y		**Unit**	**Scale**	**Ref. value**	**Data width (bits)**	**Unit**	**Scale**	**Data Width (Chars)**
~~015040~~	~~Aerosol optical depth at 0.55 micron (see Note A)~~	~~numeric~~	4	~~0~~	~~24~~	~~numeric~~	4	~~8~~
015041	*Ratio of small mode aerosol optical depth at 0.55 micron (see Note B)*	numeric	6 (4)	0	20 (14)	numeric	6 (4)	7 (5)
015042	Reflectance (see Note C)	numeric	6 (4)	0	20 (14)	numeric	6 (4)	7 (5)
015043	No. of averaging kernel layers (see Note D)	numeric	0	0	10	numeric	0	4
015044	Averaging kernel value (see Note E)	numeric	6 (4)	$-5x10^6$ ($-5x10^4$)	24 (17)	numeric	6 (4)	8 (6)
015045	Snow/ice indicator	Flag table	0	0	2	Flag table	0	1
015046	Cloud amount percentage interval	Code Table	0	0	3	Code Table	0	1

Notes:

~~A. Assumed same range and precision as for Optical Depth (0 15 024) proposed by Pelletier and Rochon.~~
B. Minimum value = 0.0, maximum value = 1.0, precision = 0.000001 (0.0001)
C. Minimum value = 0.0, maximum value = 1.0, precision = 0.000001 (0.0001)
D. Allow up to 1024 averaging kernel layers (as with Number of retrieved layers (0 10 040))
E. Minimum = -5.0, maximum = 5.0, precision = 0.000001 (0.0001)

New Flag Tables 015045

Cloud mask and snow/ice indicator

Bit No.	
1	Snow/ice present
All 2	Missing value

New Code Tables 015046

Cloud amount percentage interval

Code figure	
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

Additions to existing Code Tables

0 13 040 ***Surface flag***

Code figure	
0	Land
1	Reserved
2	Near coast
3	Ice
4	Possible ice
5	Ocean
6	Coast
7	***Desert***
8-14	Reserved
15	Missing value

Additions to *proposed* Code Tables

0 08 043 ***Atmospheric chemical or physical constituent type***

Code figure	
0	Ozone (O_3)
1	Water vapour (H_2O)
2	Methane (CH_4)
3	Carbon dioxide (CO_2)
4	***Carbon monoxide (CO)***
5	***Nitrogen dioxide (NO_2)***
6	***Nitrous oxide (N_2O)***
7	***Formaldehyde (HCHO)***
8	***Sulphur dioxide (SO_2)***

9-24	Reserved
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***~~	~~***Continental (generic)***~~
~~***33***~~	~~***Maritime (generic)***~~
~~***34***~~	~~***Sulfate***~~
35-200	Reserved
201-254	Reserved for local use
255	Missing value

IN RELATION TO PARAGRAPH 3.10.3:

At the previous ET/DR+C meeting in Kuala Lumpur (June 2004), formal pre-operational approval was given to several descriptors that had previously been allocated (and subsequently validated) for use by the U.S. Environmental Protection Agency (EPA) in reporting ozone concentrations in BUFR/CREX. The EPA would now like to begin developing similar products for the reporting of concentrations of fine particulate matter, which consists of random particles of dust, dirt and other atmospheric contaminants trapped within a monitoring filter from a given volume of air and then measured by mass. Since the particles are of a mixed and varying chemical composition, there is no way to convert such mass measurements to moles, which precludes the use of the existing BUFR/CREX descriptor 0-15-026/B-15-026. Therefore a new descriptor is required for reporting the concentration of such particles as a density (mass per unit volume). The mass amounts are directly measured in units of micrograms (per cubic meter), so an appropriate scale factor was selected in order to convert such values to the SI unit of kilograms.

Since proposed Code Table 0 08 043 remains to be validated, and there is an ongoing operational requirement at the US Environmental Protection Agency, the Team proposed to keep using Code Table 0 15 025 for now and maintained the proposal to add new entries 11 and 12 in pre-operational mode.

Add the following new entries to existing BUFR/CREX code table 0-15-025/B-15-025 (i.e. "type of pollutant"):

11 Fine particulate matter (diameter < 2.5 microns)
12 Fine particulate matter (diameter < 10 microns)

A provision will be added to the merged proposal, suggesting that once the descriptors have been accepted for pre-operational use, the following note should be added to Class 15 in the Manual on Codes: "For reporting of the identity of an atmospheric pollutant or constituent, the use of 0 08 043 is preferred to the use of 0 15 025".

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

PROPOSAL FOR SIGMET

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	Change in status of following product	Code table	0	0	3	Code table	0	1
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 the descriptors to Table B within BUFR:

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** **Change in status of following product**
0	Cancelled
1-6	Reserved
7	Missing value

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

New Table D descriptors:

		(Description of a feature in 3-D or 2-D; in the last case replication count = 1)
3 01 027	1 01 000	Replicate one descriptor
	0 31 001	Replication count
	3 01 028	Description of horizontal section [1]
		(Horizontal section of a feature described as a polygon, line or point; in the last case replication count = 1)
3 01 028	0 33 042	Type of limit represented by following (flight level) value [2]
	0 07 010	Flight Level
	1 02 000	Replicate two descriptors [3]
	0 31 001	Replication count
	0 05 002	Latitude (coarse accuracy)
	0 06 002	Longitude (coarse accuracy)
	0 19 007	Radius of feature [4]
		(SIGMET header)
3 16 030	1 02 002	Replication of 2 descriptors two times (Define validity period)
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
	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

[1] 3-D features may be described by a set of 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.

[2] 3-D features may alternatively be described by a single horizontal section with an appropriate value for 0 33 042 reported in order to indicate, e.g., an open-ended region directly above the reported flight level (value 1), a region directly below the reported flight level and extending to the surface (value 3), etc. In such cases, the corresponding horizontal section description applies throughout the entire region. Otherwise, the value reported for 0 33 042 shall be "missing".

[3] A polygon shall be described by a sequence of contiguous points in accordance with the note to code table 0 08 007.

[4] The value reported for 0 19 007 shall be "missing" unless the horizontal section to be described is a circle.

		(SIGMET, Obs or Fcst 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
	0 08 007	Dimensional significance, 0=point, 2=area, 3=volume
	3 01 027	Description of feature
	0 08 007	Dimensional significance (Missing=cancel)
	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, Fcst position)
3 16 032	0 08 021	Time Significance, 4=Forecast
	3 01 011	Year, Month, Day
	3 01 012	Hour, Minute
	0 08 007	Dimensional significance, 0=point, 2=area, 3=volume
	3 01 027	Description of feature
	0 08 007	Dimensional significance, Missing=cancel
	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 03 000	Replicate 3 descriptors
	0 31 001	Replication count
	0 08 007	Dimensional significance, 0=point, 2=area, 3=volume
	3 01 027	Description of feature
	0 08 007	Dimensional significance, Missing=cancel
	0 08 021	Time significance, Missing=cancel

		(Volcanic Ash SIGMET)
3 16 034	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 Obs or Fcst location and motion
	1 01 000	Delayed replication
	0 31 000	Short replication factor
	3 16 032	SIGMET Fcst position
	1 01 000	Delayed replication
	0 31 001	Delayed replication factor
	3 16 033	SIGMET Outlook
	0 08 011	Meteorological feature, Missing=Cancel
		(Thunderstorm SIGMET)
3 16 035	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 Obs or Fcst location and motion
	0 08 011	Meteorological feature, Missing=Cancel

		(Tropical Cyclone SIGMET)
3 16 036	3 16 030	SIGMET Header
	0 08 011	Meteorological feature, 22=Tropical Cyclone
	0 01 027	WMO storm name
	3 16 031	SIGMET Obs or Fcst location and motion
	1 01 000	Delayed replication
	0 31 000	Short replication factor
	3 16 032	SIGMET Fcst position
	1 01 000	Delayed replication
	0 31 001	Delayed replication factor
	3 16 033	SIGMET Outlook
	0 08 011	Meteorological feature, Missing=Cancel

		(Turbulence SIGMET)
3 16 037	3 16 030	SIGMET header
	0 08 011	Meteorological feature, 13=Turbulence
	0 11 031	Degree of turbulence, 10=Mod, 11=Severe
	3 16 031	SIGMET Obs or Fcst location and motion
	0 08 011	Meteorological feature, Missing=Cancel
		(Icing SIGMET)
3 16 038	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 precip, bit 3=Liquid freezing precip or all 30 bits = Missing
	3 16 031	SIGMET Obs or Fcst location and motion
	0 08 011	Meteorological feature, Missing=Cancel
		(Mountain Wave, Duststorm or Sandstorm SIGMET)
3 16 039	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 Obs or Fcst location and motion
	0 08 011	Meteorological feature, Missing=Cancel

		(Cancellation of SIGMET)
3 16 040	3 16 030	SIGMET header
	0 08 079	Change in status of following product, 0 = Cancelled
	1 02 002	Replication of 2 descriptors two times (Define validity period)
	3 01 011	Year, Month, Day of the SIGMET to be cancelled
	3 01 012	Hour, Minute 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	Change in status of following product, Missing = Cancel

ANNEX TO PARAGRAPH 3.5

In BUFR Code Manual:

Revise Note (2) under Section 1 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.

In any case, 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.

ANNEX TO PARAGRAPH 3.6

The Team recommended the inclusion of entries in Common Code C-3 for animal instruments as listed below:

995 Mammal animals
996 Other animals

ANNEX TO PARAGRAPH 3.10.1

1. Compression of CCITT IA5 elements

Current version of regulation 94.6.3, in particular sub-notes (iv) and (v) to Note (2), results into increasing of the data volume if character data are compressed.

Proposal 1:

It is proposed to change the current text of 94.6.3 **Note (2), sub-note (iv)**
"...or for character data, specifying number of octets representing the character string."
to read
"...or for character data, specifying number of octets **needed for representing the character string in the data subsets.**"
Moreover, it is proposed change the current text of 94.6.3 **Note (2), sub-note (v)**
"Actual values, V, will then be obtained ..."
to read
"Actual values, V, **other than character values,** will then be obtained ...".

2. Indirect reference to descriptors – Reg. 94.5.6.2

Current Regulation 94.5.6.2 reads:
"A sequence descriptor shall be equivalent to the corresponding list of descriptors in Table D."
This statement is fully valid when data are being expanded. Data producers and authors of data templates, however, have to pay attention to the fact that if a sequence descriptor is located under a replication descriptor 1 X Y, the X has to be modified when the sequence descriptor is replaced by the corresponding list of descriptors from Table D.

Proposal 2:
It is proposed to add a **Note under Regulation 94.5.6.2**:
If a sequence descriptor is included within the scope of a replication descriptor 1 X Y, the number of descriptors to be repeated shall be modified if the sequence descriptor is replaced by the corresponding list of descriptors from Table D.

3. Definition of operator 2 02 Y

The current definition of 2 02 Y reads:
"Add Y-128 to scale in Table B for elements which are not code or flag tables."
CCITT IA5 elements, however, should always have their scale = 0. Therefore, 2 02 Y should not apply to CCITT IA5 data.

Proposal 3:
It is proposed to modify the definition of 2 02 Y to read:
"**Add (Y-128) to the scale given for each data element in Table B, other than CCITT IA5 (character) data, code or flag tables.**"

4. Note (7) under the BUFR Table C

The Note (7) referring to 2 04 YYY reads:
"The data description operator 2 04 YYY shall be followed immediately by the descriptor 0 31 021 to indicate the meaning of the associated field".
According to this Note, 2 04 000 should be also followed by the descriptor 0 31 021. According to Note (9), however, inclusion of the descriptor 0 31 021, defined or redefined within the scope of a 2 04 YYY, is pointless outside the scope of this 2 04 YYY.

Proposal 4:
It is proposed to modify Note (7) to read:
"The data description operator 2 04 YYY**, other then 2 04 000,** shall be followed immediately by the descriptor 0 31 021 to indicate the meaning of the associated field".

5. Code figure 6 in the code table 0 31 021

The code figure 6 in 0 31 021 is defined as "Quality control flag according to GTSPP". The entries of the detailed description of the associated field (0 = unqualified to 9 = missing) are values, not bit numbers.

Proposal 5:
It is proposed to rename code figure 6 to read:
"**4-bit indicator of quality control class** according to GTSPP".

6. Note (5) under BUFR Table C

The Note (5)(a) specifies that each new definition adds to the currently defined associated field. It does not specify, however, the order of the included associated information. The order might either correspond with the order of the associated field significance or it might be reversed to it, i.e. the first included associated information would be related to the most recently defined associated field. The later approach would be in compliance with the procedure of cancellation in Note (5)(b), according to which cancellation 2 04 000 applies to the most recently defined addition to the associated field. The former alternative is reflected in the proposal below.

Proposal 6:
It is proposed to supplement Note (5)(a) with the following text:

"The order of the included associated information shall correspond with the order in which the associated fields have been defined."

ANNEX TO PARAGRAPH 3.10.2

Add new entry in the Common Code Table C-5: Satellite identifier:

Code figure for I6I6I6	BUFR 001007	
785	785	AURA

ANNEX TO PARAGRAPH 3.10.4

1) Add the following new entry to existing BUFR/CREX code table 0-02-169/B-02-169 (i.e. “type of anemometer”):
   3 Sonic

2) Add the following new entries to existing Common Code Table C-12 for originating center #7 (i.e. U.S/NCEP):
   15 North American Regional Reanalysis Project
   16 Space Environment Center

3) Rename the following entry in Common Code Table C-12, in order to reflect the changed name of the underlying sub-center:
   6 Ocean Prediction Center

ANNEX TO PARAGRAPH 3.10.5

Proposed additions to the existing Flag table 0 08 042:

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

ANNEX TO PARAGRAPH 3.10.6

In Code Table 0-02-163

Change: 13, Parameter = Reserved
to: 13, Parameter = IR / two WV channel ratioing method

ANNEX TO PARAGRAPH 3.10.7

ADDITIONAL ENTRIES FOR POLAR SATELLITE DATA

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

Add Note: MHS = Mircowave Humidity Sounder

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

Add Note: MHS = Mircowave Humidity Sounder

Code Table 0-02-151

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

Add Note: MHS = Mircowave Humidity Sounder

Sequence Descriptor 3-10-010

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

Add Note: MHS = Mircowave Humidity Sounder

2) IASI

The IASI instrument is a hyperspectral sounder, which will fly on the Metop spacecraft operated by EUMETSAT. 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 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 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	None	0	0	16
(0-14-047)	Scaled mean AVHRR radiance	None	0	0	31
(0-14-048)	Scaled std dev AVHRR radiance	None	0	0	31
(0-25-140)	Start channel	None	0	0	14
(0-25-141)	End channel	None	0	0	14
(0-25-142)	Channel scale factor	None	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 quality function	Numeric	0	0	24

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

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

3) ASCAT

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
0-21-062	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
2-01-132	Increase data width by 4 bits
0-02-134	Antenna beam azimuth
2-01-000	Cancel change data width
2-02-000	Cancel change scaling
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
(0-21-150)	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 quantity	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	Numeric	3	0	10

	function presence				
(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 3.10.8

PART A

I. Descriptors

I-1 For RADOB

Class 02 - Instrumentation

0	02	160	Wave length of the radar	Code table	0	0	4	Code table	0	2

Class 19 - Synoptic features

0	19	100	Time interval to calculate the movement of the tropical cyclone	Code table	0	0	4	Code table	0	2
0	19	101	Accuracy of the position of the centre of the tropical cyclone	Code table	0	0	4	Code table	0	2
0	19	102	Shape and definition of the eye of the tropical cyclone	Code table	0	0	3	Code table	0	1
0	19	103	Diameter of major axis of the eye of the tropical cyclone	Code table	0	0	4	Code table	0	2
0	19	104	Change in character of the eye during the 30 minutes	Code table	0	0	4	Code table	0	2
0	19	105	Distance between the end of spiral band and the centre	Code table	0	0	4	Code table	0	2

I-2 For TRACKOB

Class 02 - Instrumentation

0	02	042	Indicator for sea surface current speed	Code table	0	0	2	Code table	0	1

Class 04 - Location (time)

0	04	080	Averaging period for following value	Code table	0	0	4	Code table	0	2

Class 22 - Oceanographic elements

0	22	005	Direction of sea surface current	Degree true	0	0	9	Degree true	0	3
0	22	032	Speed of sea surface current	$m\ s^{-1}$	2	0	13	$m\ s^{-1}$	2	4
0	22	049	Sea surface temperature	K	2	0	15	K	2	5
0	22	059	Sea surface salinity	Part per thousand	2	0	14	Part per thousand	2	5

I-3 For SAREP

Class 19 - Synoptic features

0	19	106	Identification number of tropical cyclone	Numeric	0	0	7	Numeric	0	3
0	19	107	Time interval of the tropical cyclone analysis	Code table	0	0	4	Code table	0	2
0	19	108	Accuracy of geographical position of the tropical cyclone	Code table	0	0	3	Code table	0	1
0	19	109	Mean diameter of the overcast cloud of the tropical cyclone	Code table	0	0	4	Code table	0	2

0	19	110	Apparent 24-hour change in intensity of the tropical cyclone	Code table	0	0	4	Code table	0	2
0	19	111	Current Intensity (CI) number of the tropical cyclone	Numeric	1	0	7	Numeric	1	3
0	19	112	Data tropical (DT) number of the tropical cyclone	Numeric	1	0	7	Numeric	1	3
0	19	113	Cloud pattern type of the DT-number	Code table	0	0	4	Code table	0	2
0	19	114	Model Expected tropical (MET) number of the tropical cyclone	Numeric	1	0	7	Numeric	1	3
0	19	115	Trend of past 24-hour change (+: Developed, -: Weakened)	Numeric	1	-30	6	Numeric	1	2
0	19	116	Pattern tropical (PT) number of the tropical cyclone	Numeric	1	0	7	Numeric	1	3
0	19	117	Cloud picture type of the PT-number	Code table	0	0	3	Code table	0	1
0	19	118	Final tropical (T) number of the tropical cyclone	Numeric	1	0	7	Numeric	1	3
0	19	119	Type of the final T-number	Code table	0	0	3	Code table	0	1
0	19	150	Typhoon International Common Number (Typhoon Committee)	CCITTIA5	0	0	32	Character	0	4

Class 25 - Processing information

0	25	150	Satellite intensity analysis method of tropical cyclone	Code table	0	0	4	Code table	0	2

Category 01 - Location and identification sequence

3	01	005	0 01 035 0 01 034	Originating centre Identification of originating/generating sub-centre

II. Code Tables

II-1 For RADOB

0 02 160
Wave length of the radar

Code figure	
0	Reserved
1	10 to less than 20 mm
2	Reserved
3	20 to less than 40 mm
4	Reserved
5	40 to less than 60 mm
6	Reserved
7	60 to less than 90 mm
8	90 to less than 110 mm
9	110 mm and greater
10-14	Not used
15	Missing value

0 19 100

Time interval to calculate the movement of the tropical cyclone

Code figure	
0-2	Not used
3	During the preceding 15 minutes
4	During the preceding 30 minutes
5	During the preceding 1 hour
6	During the preceding 2 hours
7	During the preceding 3 hours
8	During the preceding 6 hours
9	During a period of more than 6 hours
10	Undetermined
11-14	Not used
15	Missing value

0 19 101

Accuracy of the position of the centre of the tropical cyclone

Code figure	
0	Reserved
1	Eye visible on radar scope, accuracy good (within 10 km)
2	Eye visible on radar scope, accuracy fair (within 30 km)
3	Eye visible on radar scope, accuracy poor (within 50 km)
4	Position of the centre within the area covered by the radar scope, determination by means of the spiral-band overlay, accuracy good (within 10 km)
5	Position of the centre within the area covered by the radar scope, determination by means of the spiral-band overlay, accuracy fair (within 30 km)
6	Position of the centre within the area covered by the radar scope, determination by means of the spiral-band overlay, accuracy poor (within 50 km)
7	Position of the centre outside the area covered by the radar scope, extrapolation by means of the spiral-band overlay
8-9	Reserved
10	Accuracy undetermined
11-14	Not used
15	Missing value

0 19 102

Shape and definition of the eye of the tropical cyclone

Code figure		
0	Circular	
1	Elliptical — the minor axis is at least 3/4 the length of the major axis	*well defined*
2	Elliptical — the minor axis is less than 3/4 the length of the major axis	*well defined*
3	Apparent double eye	*well defined*
4	Other shape	*well defined*
5	Ill defined	
6	Undetermined	
7	Missing	

0 19 103
Diameter of major axis of the eye of the tropical cyclone

Code figure	
0	Less than 5 km
1	5 to less than 10 km
2	10 to less than 15 km
3	15 to less than 20 km
4	20 to less than 25 km
5	25 to less than 30 km
6	30 to less than 35 km
7	35 to less than 40 km
8	40 to less than 50 km
9	50 km and greater
10	Undetermined
11-14	Not used
15	Missing value

0 19 104
Change in character of the eye during the 30 minutes

Code figure	
0	Eye has first become visible during the past 30 minutes
1	No significant change in the characteristics or size of the eye
2	Eye has become smaller with no other significant change in characteristics
3	Eye has become larger with no other significant change in characteristics
4	Eye has become less distinct with no significant change in size
5	Eye has become less distinct and decreased in size
6	Eye has become less distinct and increased in size
7	Eye has become more distinct with no significant change in size
8	Eye has become more distinct and decreased in size
9	Eye has become more distinct and increased in size
10	Change in character and size of eye cannot be determined
11-14	Not used
15	Missing value

0 19 105
Distance between the end of spiral band and the centre

Code figure	
0	0 to less than 100 km
1	100 to less than 200 km
2	200 to less than 300 km
3	300 to less than 400 km
4	400 to less than 500 km
5	500 to less than 600 km
6	600 to less than 800 km
7	800 km or more
8-9	Reserved
10	Doubtful or undetermined
11-14	Not used
15	Missing value

II-2 For TRACKOB

0 02 042
Indicator for sea surface current speed

Code figure	
0	Value originally reported in m/s
1	Value originally reported in knots
2	No sea current data available
3	Missing

0 04 080
Averaging period for following value

Code figure	
0	Spot values
1	Less than 15 minutes
2	From 15 to 45 minutes
3	More than 45 minutes
4-8	Reserved
9	Data not available
10-14	Not used
15	Missing

II-3 For SAREP

0 19 107
Time interval of the tropical cyclone analysis

Code figure	
0	Less than 1 hour
1	1 to less than 2 hours
2	2 to less than 3 hours
3	3 to less than 6 hours
4	6 to less than 9 hours
5	9 to less than 12 hours
6	12 to less than 15 hours
7	15 to less than 18 hours
8	18 to less than 21 hours
9	21 to less than 30 hours
10-14	Not used
15	Missing value

0 19 108
Accuracy of geographical position of the tropical cyclone

Code figure	
0	Cyclone centre within 10 km of the transmitted position
1	Cyclone centre within 20 km of the transmitted position
2	Cyclone centre within 50 km of the transmitted position
3	Cyclone centre within 100 km of the transmitted position
4	Cyclone centre within 200 km of the transmitted position
5	Cyclone centre within 300 km of the transmitted position
6	Cyclone centre undetermined
7	Missing value

0 19 109
Mean diameter of the overcast cloud of the tropical cyclone

Code figure	
0	Less than 1° of latitude
1	1° to less than 2° of latitude
2	2° to less than 3° of latitude
3	3° to less than 4° of latitude
4	4° to less than 5° of latitude
5	5° to less than 6° of latitude
6	6° to less than 7° of latitude
7	7° to less than 8° of latitude
8	8° to less than 9° of latitude
9	9° of latitude or more
10	Undetermined
11-14	Not used
15	Missing value

0 19 110
Apparent 24-hour change in intensity of the tropical cyclone

Code figure	
0	Much weakening
1	Weakening
2	No change
3	Intensification
4	Strong Intensification
5-8	Reserved
9	Not observed previously
10	Undetermined
11-14	Not used
15	Missing value

0 19 113

Cloud pattern type of the DT-number

Code figure	Type
1	Curved Band
2	Shear
3	Eye
4	Banding Eye
□	Central Dense Overcast (CDO)
6	Embedded Center
7	Center Cold Cover (CCC)
8-14	Reserved
15	Missing value

0 19 117

Cloud picture type of the PT-number

Code figure	Type
1	A (Curved Band)
2	B (CDO)
3	C (Shear)
4-6	Reserved
7	Missing value

0 19 119

Type of the final T-number

Code figure	Type
1	DT-number
2	PT-number
3	MET-number
4-6	Reserved
7	Missing value

0 25 150

Satellite intensity analysis method of tropical cyclone

Code figure	Method
1	The Dvorak's VIS (visual imagery) intensity analysis
2	The Dvorak's EIR (Enhanced Infrared imagery) intensity analysis
3-14	Reserved
15	Missing value

PART B

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

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

Proposal:
[3 16 050] = 3 01 001 + 3 01 011 + 3 01 012 + 0 02 160 + 0 08 005 + 0 05 002
+ 0 06 002 + 0 08 005 + 0 19 100 + 0 19 005 + 0 19 006 + 0 19 101
+ 0 19 102 + 0 19 103 + 0 19 104 + 0 19 105

Table reference		Element name	Unit	Scale	Reference value	Data width (bits)
		Station identification and time				
3 01 001	0 01 001	WMO block number	Numeric	0	0	7
	0 01 002	WMO station number	Numeric	0	0	10
3 01 011	0 04 001	Year	Year	0	0	12
	0 04 002	Month	Month	0	0	4
	0 04 003	Day	Day	0	0	6
3 01 012	0 04 004	Hour	Hour	0	0	5
	0 04 005	Minute	Minute	0	0	6
		Radar information				
0 02 160	*NEW*	Wave length of the radar	Code table	0	0	4
		Tropical Cyclone				
0 08 005		Meteorological attribute significance (=1)	Code table	0	0	4
0 05 002		Latitude (coarse accuracy)	Degree	2	–9000	15
0 06 002		Longitude (coarse accuracy)	Degree	2	–18000	16
0 08 005		Meteorological attribute significance (set to missing to cancel the previous value)	Code table	0	0	4
0 19 100	*NEW*	Time interval to calculate the movement of the tropical cyclone	Code table	0	0	4
0 19 005		Direction of motion of feature	Degree true	0	0	9
0 19 006		Speed of motion of feature	$m\ s^{-1}$	2	0	14
0 19 101	*NEW*	Accuracy of the position of the centre of the tropical cyclone	Code table	0	0	4
0 19 102	*NEW*	Shape and definition of the eye of the tropical cyclone	Code table	0	0	3
0 19 103	*NEW*	Diameter of major axis of the eye of the tropical cyclone	Code table	0	0	4
0 19 104	*NEW*	Change in character of the eye during the 30 minutes	Code table	0	0	4
0 19 105	*NEW*	Distance between the end of spiral band and the centre	Code table	0	0	4

2. TRACKOB Template

Proposal:

[3 08 010] = 0 01 011 + 1 13 000 + 0 31 001 + 3 01 011 + 3 01 012 + 3 01 021
+ 0 04 080 + 0 22 049 + 0 04 080 + 0 22 059 + 0 04 080 + 0 22 005
+ 0 02 042 + 0 22 032 + 0 02 042 + 0 04 080

Table reference		Element name	Unit	Scale	Reference value	Data width (bits)
0 01 011		Ship or mobile land station identifier	CCITT IA5	0	0	72
1 13 000		Delayed replication of 13 descriptors				
0 31 001		Delayed descriptor replication factor	Numeric	0	0	8
3 01 011	0 04 001	Year	Year	0	0	12
	0 04 002	Month	Month	0	0	4
	0 04 003	Day	Day	0	0	6
3 01 012	0 04 004	Hour	Hour	0	0	5
	0 04 005	Minute	Minute	0	0	6
3 01 021	0 05 001	Latitude (high accuracy)	Degree	5	–9000000	25
	0 06 001	Longitude (high accuracy)	Degree	5	–18000000	26
0 04 080	NEW	Averaging period for following value	Code table	0	0	4
0 22 049	NEW	Sea surface temperature	K	2	0	15
0 04 080	NEW	Averaging period for following value	Code table	0	0	4
0 22 059	NEW	Sea surface salinity	Part per thousand	2	0	14
0 04 080	NEW	Averaging period for following value	Code table	0	0	4
0 22 005	NEW	Direction of sea surface current	Degree true	0	0	9
0 02 042	NEW	Indicator for sea surface current speed	Code table	0	0	2
0 22 032	NEW	Speed of sea surface current	ms-1	2	0	13
0 02 042	NEW	Indicator for sea surface current speed (cancel)	Code table	0	0	2
0 04 080	NEW	Averaging period for following value (cancel)	Code table	0	0	4

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

Proposal:

[3 16 052] = 3 01 005 + 3 01 011 + 3 01 012 + 0 01 007 + 0 25 150 + 1 22 000
+0 31 001 + 0 01 027 + 0 19 150 + 0 19 106 + 0 08 005 + 0 05 002
+0 06 002 + 0 08 005 + 0 19 107 + 0 19 005 + 0 19 006 + 0 19 108
+0 19 109 + 0 19 110 + 0 19 111 + 0 19 112 + 0 19 113 + 0 19 114
+0 19 115 + 0 19 116 + 0 19 117 + 0 19 118 + 0 19 119

Table reference		Element name	Unit	Scale	Reference value	Data width (bits)
		(Station identification and time)				
3 01 005 NEW	0 01 035	Originating centre	Common code table C-11	0	0	16
	0 01 034	Identification of originating/generating sub-centre	Common code table C-12	0	0	8
3 01 011	0 04 001	Year	Year	0	0	12
	0 04 002	Month	Month	0	0	4
	0 04 003	Day	Day	0	0	6
3 01 012	0 04 004	Hour	Hour	0	0	5
	0 04 005	Minute	Minute	0	0	6
		(Satellite information)				
0 01 007		Satellite identifier	Code table	0	0	10
0 25 150	*NEW*	Satellite intensity analysis method of tropical cyclone	Code table	0	0	4
		(Tropical cyclone information)				
1 22 000		Delayed replication of 22 descriptors				
0 31 001		Delayed descriptor replication factor	Numeric	0	0	8
0 01 027		WMO long storm name	CCITT IA5	0	0	80
0 19 150	*NEW*	Typhoon International Common Number (Typhoon Committee)	CCITT IA5	0	0	32
0 19 106	*NEW*	Identification number of tropical cyclone	Numeric	0	0	7
0 08 005		Meteorological attribute significance (=1)	Code table	0	0	4
0 05 002		Latitude (coarse accuracy)	Degree	2	–9000	15
0 06 002		Longitude (coarse accuracy)	Degree	2	–18000	16
0 08 005		Meteorological attribute significance (set to missing to cancel the previous value)	Code table	0	0	4
0 19 107	*NEW*	Time interval of the tropical cyclone analysis	Code table	0	0	4
0 19 005		Direction of motion of feature	Degree true	0	0	9
0 19 006		Speed of motion of feature	$m\ s^{-1}$	2	0	14
0 19 108	*NEW*	Accuracy of geographical position of the tropical cyclone	Code table	0	0	3
0 19 109	*NEW*	Mean diameter of the overcast cloud of the tropical cyclone	Code table	0	0	4
0 19 110	*NEW*	Apparent 24-hour change in intensity of the tropical cyclone	Code table	0	0	4
0 19 111	*NEW*	Current Intensity (CI) number of the tropical cyclone	Numeric	1	0	7
0 19 112	*NEW*	Data tropical (DT) number of the tropical cyclone	Numeric	1	0	7
0 19 113	*NEW*	Cloud pattern type of the DT-number	Code table	0	0	4
0 19 114	*NEW*	Model Expected tropical (MET) number of the tropical cyclone	Numeric	1	0	7
0 19 115	*NEW*	Trend of the past 24-hour change (+:	Numeric	1	-30	6

		Developed, -: Weakened)				
0 19 116	*NEW*	Pattern tropical (PT) number of the tropical cyclone	Numeric	1	0	7
0 19 117	*NEW*	Cloud picture type of the PT-number	Code table	0	0	3
0 19 118	*NEW*	Final tropical (T) number of the tropical cyclone	Numeric	1	0	7
0 19 119	*NEW*	Type of the final T-number	Code table	0	0	3

ANNEX TO CHAPTER 5.1.2

B/C1 – REGULATIONS FOR REPORTING SYNOP DATA IN BUFR/CREX

BUFR TEMPLATE FOR SYNOPTIC REPORTS FROM FIXED LAND STATIONS SUITABLE FOR SYNOP OBSERVATION DATA

3 01 090			**Fixed surface station identification, time, horizontal and vertical coordinates**		Unit, scale
	3 01 004	0 01 001	WMO block number	**II**	Numeric, 0
		0 01 002	WMO station number	**iii**	Numeric, 0
		0 01 015	Station or site name		CCITT IA5, 0
		0 02 001	Type of station	**(i_x)**	Code table, 0
	3 01 011	0 04 001	Year		Year, 0
		0 04 002	Month		Month, 0
		0 04 003	Day	**YY**	Day, 0
	3 01 012	0 04 004	Hour	**GG**	Hour, 0
		0 04 005	Minute	**gg**	Minute, 0
	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
			Pressure data		
3 02 031	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
	0 10 062		24-hour pressure change	**$p_{24}p_{24}p_{24}$**	Pa, –1
	0 07 004		Pressure (standard level)	**a_3**	Pa, –1
	0 10 009		Geopotential height of the standard level	**hhh**	gpm, 0
3 02 035			**Basic synoptic "instantaneous" data**		
			Temperature and humidity data		
	3 02 032	0 07 032	Height of sensor above local ground (for temperature measurement)		m, 2
		0 12 101	Temperature/dry-bulb temperature(sc.2)	**s_nTTT**	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 02 033	*0 07 032*	Height of sensor above local ground (for visibility measurement)		m, 2
		0 20 001	Horizontal visibility	**VV**	m, –1
			Precipitation past 24 hours		
	3 02 034	0 07 032	***Height of sensor above local ground*** (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 local ground*** (set to missing to cancel the previous value)		m, 2
			Cloud data		
	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
			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’H’**	m, -1
	0 20 017		Cloud top description **C_t**	Code table, 0
			Direction of cloud drift gr. **$56D_LD_MD_H$**	
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. **$57CD_ae_C$**	
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
			State of ground, snow depth, ground minimum temperature	
3 02 037	0 20 062		State of ground (with or without snow) **E** or **E’**	Code table, 0
	0 13 013		Total snow depth **sss**	m, 2
	0 12 113		Ground minimum temperature (scale2), past 12 hours **$s_nT_gT_g$**	K, 2
3 02 043			**Basic synoptic “period” data**	
			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
			Sunshine data (from 1 hour and 24 hour period)	
	1 01 002		Replicate 1 descriptors 2 times	
	3 02 039	0 04 024	Time period in hours	Hour, 0
		0 14 031	Total sunshine **SS** and **SSS**	Minute, 0
			Precipitation measurement	
	3 02 040	0 07 032	Height of sensor above local ground (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	
	3 02 041	0 07 032	Height of sensor above local ground (for temperature measurement)	m, 2
		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 02 042	0 07 032	Height of sensor above local ground (for wind measurement)	m, 2
		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 03 002	Replicate next 3 descriptors 2 times	
		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 910**f_mf_m**, 911**f_xf_x**	m s^{-1}, 1
	0 07 032		Height of sensor above local ground (set to missing to cancel the previous value)	m, 2
			Evaporation data	
3 02 044	0 04 024		Time period in hours	Hour, 0
	0 02 004		Type of instrument for evaporation or crop type for evapotranspiration **i_E**	Code table, 0
	0 13 033		Evaporation /evapotranspiration **EEE**	kg m^{-2}, 1
			Radiation data (from 1 hour and 24 hour period)	
1 01 002			Replicate next descriptor 2 times	
3 02 045	0 04 024		Time period in hours	Hour, 0
	0 14 002		Long-wave radiation, integrated over period specified 553SS 4**FFFF** or 553SS 5**FFFF**, 55SSS 4**$F_{24}F_{24}F_{24}F_{24}$** or 55SSS 5**$F_{24}F_{24}F_{24}F_{24}$**	J m^{-2}, -3
	0 14 004		Short-wave radiation, integrated over period specified 553SS 6**FFFF**, 55SSS 6**$F_{24}F_{24}F_{24}F_{24}$**	J m^{-2}, -3
	0 14 016		Net radiation, integrated over period specified 553SS 0**FFFF** or 553SS 1**FFFF**, 55SSS 0**$F_{24}F_{24}F_{24}F_{24}$** or 55SSS 1**$F_{24}F_{24}F_{24}F_{24}$**	J m^{-2}, -4
	0 14 028		Global solar radiation (high accuracy), integrated over period specified 553SS 2**FFFF**, 55SSS 2**$F_{24}F_{24}F_{24}F_{24}$**	J m^{-2}, -4

	0 14 029		Diffuse solar radiation (high accuracy), integrated over period specified 553SS 3**FFFF**, 55SSS 3$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
	0 14 030		Direct solar radiation (high accuracy), integrated over period specified 55408 4**FFFF**, 55508 5$F_{24}F_{24}F_{24}F_{24}$	J m^{-2}, -4
3 02 046			**Temperature change** group **54$g_0s_nd_T$**	
	0 04 024		Time period or displacement	Hour, 0
	0 04 024		Time period or displacement (see Note 3)	Hour, 0
	0 12 049		Temperature change over period specified **s_nd_T**	K, 0

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

Regulations:

B/C1.1 Section 1 of TDCF

B/C1.1.1 Entries required in Section 1 of BUFR

The following entries shall be included in BUFR Section 1:

- BUFR master table,
- identification of originating/generating centre,
- identification of originating/generating sub-centre,
- update sequence number,
- identification of inclusion of optional section,
- data category (= 000 for SYNOP data),
- international data sub-category (see Note below),
- local data subcategory,
- version number of master table,
- version number of local tables,
- year (year of the century up to BUFR edition 3),
- month (standard time),
- day (standard time = YY in the abbreviated telecom. header),
- hour (standard time = GG in the abbreviated telecom. header),
- minute (standard time = 00).

Note:
If required, the international data sub-category shall be included for SYNOP data as
= 002 at main synoptic times 00, 06, 12, 18 UTC,
= 001 at intermediate times 03, 09, 15, 21 UTC,
= 000 at observation times 01, 02, 04, 05, 07, 08, 10, 11, 13, 14, 16, 17, 19, 20, 22 and 23 UTC.

B/C1.1.2 Entries required in Section 1 of CREX

The following entries shall be included in CREX Section 1:

- CREX master table,

- CREX edition number,
- CREX table version number,
- version number of BUFR master table [1],
- version number of local tables [1],
- data category (= 000 for SYNOP data),
- international data sub-category [1], [2],
- identification of originating/generating centre [1],
- identification of originating/generating sub-centre [1],
- update sequence number [1],
- number of subsets [1],
- year (standard time) [1],
- month (standard time) [1],
- day (standard time) [1],
- hour (standard time) [1],
- minute (standard time = 00) [1].

Notes:
(1) Inclusion of these entries is required starting with CREX edition 2.
(2) If inclusion of international data sub-category is required, Note under B/C 1.1.1 applies.

B/C1.2 Fixed station identification, time, horizontal and vertical coordinates

B/C1.2.1 Fixed station identification

WMO block number station (0 01 001) and WMO station number (0 01 002) shall be always reported.

B/C1.2.2 Time of observation

Year (0 04 001), month (0 04 002), day (0 04 003), hour (0 04 004) and minute (0 04 005) of the actual time of observation shall be reported.
Note:
If the actual time of observation differs by 10 minutes or less from the standard time reported in Section 1, the standard time may be reported instead of the actual time of observation. [12.2.6]

B/C1.2.3 Horizontal and vertical coordinates

Latitude (0 05 001) and longitude (0 06 001) of the station shall be reported in degrees with precision in 10^{-5} of a degree.

Height of station ground above mean sea level (0 07 030) and height of barometer above mean sea level (0 07 031) shall be reported in meters with precision in tenths of a meter.

B/C 1.3 Pressure data

B/C 1.3.1 Pressure at the station level, ~~in tenths of a hectopascal~~

Pressure at the station level (0 10 004), i.e. at the level defined by 0 07 031 (height of barometer above mean sea level), shall be reported in pascals (with precision in tens of a pascal).

B/C 1.3.1.1

The station pressure shall be included in reports for global exchange from land stations, together with either the mean sea level pressure or, in accordance with Regulation B/C 1.3.5.1, with the geopotential height of a standard pressure level [12.2.4].

Note :

Inclusion of the station pressure at other times is left to the decision of individual Members.

B/C 1.3.2 Pressure ~~at~~ **reduced to mean sea level** ~~in tenths of a hectopascal~~

Pressure reduced to mean sea level (0 10 051) shall be reported in pascals (with precision in tens of a pascal).

B/C 1.3.2.1

Whenever air pressure at mean sea level can be computed with reasonable accuracy, this pressure shall be reported [12.2.3.4.1].

Notes:

(1) For a station situated in a region of normal synoptic network density, the pressure at mean sea level is considered not to be computed with reasonable accuracy when it introduces a deformation into the analysis of the horizontal pressure field which is purely local and recurring.

(2) For a station lying in a data-sparse area of the synoptic network, reasonable accuracy will be obtained when using a reduction method which has proved to be satisfactory in a region of normal network density and under similar geographic conditions.

B/C 1.3.3 Three-hour pressure change and characteristic of pressure tendency

12.2.3.5.1 Amount of pressure, *either positive, zero or negative*, expressed ~~in tenths of a hectopascal~~ in pascals (with precision in tens of a pascal) at station level, during the three hours preceding the time of observation. Unless specified otherwise by regional decision, pressure tendency shall be included whenever the three-hourly pressure tendency is available.

12.2.3.5.2 The characteristic of pressure tendency (Code table 010063) over the past three hours shall, whenever possible, be determined on the basis of pressure samplet at equi-spaced intervals not exceeding one hour.

Note :

Algorithms for selecting the appropriate code figure are included in publication WMO–No.8, Guide to Meteorological Instruments and Methods of Observation.

12.2.3.5.3 Where it is not possible to apply the algorithms specified in Regulation 12.2.3.5.2 in reports from automatic weather stations, the characteristic of pressure tendency shall be reported as 2 when the tendency is positive, as 7 when the tendency is negative, and as 4 when the atmospheric pressure is the same as three hours before.

B/C 1.3.4 24-hour pressure change:

12.4.8 ~~Surface pressure change~~

Amount of surface pressure change ~~during the past 24 hours,~~ either positive, zero or negative, ~~in tenths of a hectopascal~~ expressed in pascals (with precision in tens of a pascal) at station level, during 24 hours preceding the time of observation.

B/C 1.3.5 Geopotential height of the standard level, in geopotential meters:

12.2.3.4.2 By regional decision, a high-level station which cannot give pressure at mean sea level to a satisfactory degree of accuracy shall report both the station-level pressure and the geopotential height of an agreed standard isobaric surface. The standard isobaric level is specified by the preceding entry, i.e. by 0 07 004 (Pressure).

Note : The level chosen for each station is indicated in Volume A of publication WMO – No. 9.

Basic synoptic "instantaneous" data

Temperature and humidity data

Height of sensor above local ground (for temperature and humidity measurement), in meters (with precision in hundredths of a meter)

This datum represents the actual height of temperature and humidity sensors above ground at the point where the sensors are located.

Dry-bulb air temperature, in degrees Kelvin (with precision in hundredths of a degree Celsius Kelvin); if produced in CREX, in degrees Celsius (with precision in hundredths of a degree Celsius)

Note:

Temperature data shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

12.2.3.2 When data are not available as a result of a temporary instrument failure, automatic weather stations programmed to transmit this quantity shall include it in their reports as a missing value this quality shall be included as a missing value.

Dew-point temperature, in degrees Kelvin (with precision in hundredths of a degree Celsius Kelvin); if produced in CREX, in degrees Celsius (with precision in hundredths of a degree Celsius)

Note:

Dew-point temperature data shall be reported with precision in hundredths of a degree even if they are available with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

12.2.3.3.2 When data is not available as a result of a temporary instrument failure, automatic weather stations programmed to transmit this quantity shall include it in their reports as a missing value this quality shall be included as a missing value.

Relative humidity, in units of a percent

Both dew point and relative humidity shall be transmitted when available.

Visibility data

Height of sensor above local ground (for visibility measurement), in meters (with precision in hundredths of a meter)

If reported this datum represents the actual height of visibility sensor above ground at the point where the sensor is located. If visibility is estimated by a human observer, average height of observer's eyes above ground shall be reported.

Horizontal visibility at surface in meters (with precision in tens of meters)

12.2.1.3.1 When the horizontal visibility is not the same in different directions, the shortest distance shall be given for visibility.

Precipitation past 24 hours

Height of sensor above local ground (for precipitation measurement), in meters (with precision in hundredths of a meter)

This datum represents the actual height of the rain gauge rim above ground at the point where the rain gauge is located.

Total amount of precipitation during the 24-hour period ending at the time of observation in kilograms per square meter (with precision in tenths of a kilogram per square meter).

12.4.1 ~~Total amount of precipitation during the 24-hour period ending at the time of observation.~~ The precipitation over the past 24 hours shall be included (not missing) at least once a day at one appropriate time of the main standard times (0000, 0600, 1200, 1800 UTC).

12.2.5.4 Precipitation, when it can be and has to be reported, shall be reported as 0.0 kgm^{-2} ~~coded 0 even~~ if no precipitation were observed during the referenced period. Trace shall be reported as - 0.1 kgm^{-2}

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Cloud data

Total cloud cover, in units of a percent:

Total cloud cover shall embrace the total fraction of the celestial dome covered by clouds irrespective of their genus.

12.2.2.2.1 Total cloud cover shall be reported as actually seen by the observer during the observation.

12.2.2.2.2 Altocumulus perlucidus or Stratocumulus perlucidus ("mackerel sky") shall be reported ~~using 90%~~ as 99% or less (unless overlying clouds appear to cover the whole sky) since breaks are always present in this cloud form even if it extends over the whole celestial dome.

12.2.2.2.3 Total cloud cover shall be reported as zero when blue sky or stars are seen through existing fog or other analogous phenomena without any trace of cloud being seen.

12.2.2.2.4 When clouds are observed through fog or analogous phenomena, their amount shall be evaluated and reported as if these phenomena were non-existent.

12.2.2.2.5 Total cloud cover shall not include the amount resulting from rapidly dissipating condensation trails.

12.2.2.2.6 Persistent condensation trails and cloud masses which have obviously developed from condensation trails shall be reported as cloud, using the appropriate code figure.

Vertical significance – Code table 008002

To be written

Cloud amount of low or middle clouds (N_h) – Code table 020011

Amount of all the low clouds (clouds of the genera Stratocumulus, Stratus, Cumulus, and Cumulonimbus) present or, if no low clouds are present, the amount of all the middle clouds (clouds of the genera Altocumulus, Altostratus, and Nimbostratus) present.

12.2.7.2.1 (a) If there are low clouds then the total amount of all low clouds, as actually seen by the observer during the observation shall be reported for the cloud amount.

(b) If there are no low clouds but there are middle clouds, then the total amount of the middle clouds shall be reported for the cloud amount.

(c) If there are no low clouds and there are no middle clouds but there are high clouds (clouds of the genera Cirrus, Cirrocumulus, and Cirrostratus), then the cloud amount shall be reported as zero.

12.2.7.2.2 Altocumulus perlucidus or Stratocumulus perlucidus ("mackerel sky") shall be reported using ~~90%~~ **code figure 7or less** since breaks are always present in this cloud form even if it extends over the whole celestial dome.

12.2.7.2.3 When the clouds reported for cloud amount are observed through fog or an analogous phenomenon, the cloud amount shall be reported as if these phenomena were not present.

12.2.7.2.4 If the clouds reported for cloud amount include contrails, then the cloud amount shall include the amount of persistent contrails. Rapidly dissipating contrails shall not be included in the value for the cloud amount.

Height of base of lowest cloud in meters (with precision in tens of a meter)

Height above surface of the base of the lowest cloud seen.

12.2.1.2 When the station is in fog, a sandstorm or in blowing snow but the sky is discernable, the base of the lowest cloud shall refer to the base of the lowest cloud observed, if any. When, under the above conditions, the sky is not discernible, the base of the lowest cloud shall be reported as missing. *When no cloud are reported (Total cloud cover = 0) the value shall be reported as "missing".*

Note 1: The term « height above surface » shall be considered as being the height above the official aerodrome elevation or above station elevation at a non-aerodrome station.

Cloud type of low, middle and high clouds

12.2.7.3 The reporting of type of low, middle and high clouds (C_L, C_M, and C_H clouds) shall be as specified in publication WMO-NO. 407 – *International Cloud Atlas*, Volume I.

Individual cloud layers or masses

Vertical significance – Code table 008002

To be written

Cloud amount, type and height of base (N_s, genus C, and height h_sh_s)

12.4.10.1 Amount of individual cloud layer or mass, genus of cloud layer or mass, and height of base of individual cloud layer or mass. The number of individual cloud layers or masses shall in the absence of Cumulonimbus clouds not exceed three. Cumulonimbus clouds, when observed, shall always be reported, so that the total number of individual cloud layers or masses can be four. The selection of layers (or masses) to be reported shall be made in accordance with the following criteria :

(a) The lowest individual layer (or mass) of any amount (cloud amount at least one octa or less, but not zero) ;

(b) The next higher individual layer (or mass) the amount of which is greater than two octas;

(c) The next higher individual layer (or mass) the amount of which is greater than four octas;

(d) Cumulonimbus clouds, whenever observed and not reported under (a), (b) and (c) above.

12.4.10.2 The order of reporting the individual cloud layers or masses shall always be from lower to higher levels.

12.4.10.3 In determining cloud amounts to be reported for individual layers or masses, the observer shall estimate, by taking into consideration the evolution of the sky, the cloud amounts of each individual layer or mass at the different levels, as if no other clouds existed.

12.4.10.4 When the sky is clear, cloud amount, genus, and height shall not be reported.

12.4.10.5 If, notwithstanding the existence of fog, sandstorm, duststorm, blowing snow or other obscuring phenomena, the sky is discernible, the partially obscuring phenomena shall be disregarded. If, under the above conditions, the sky is not discernible, the cloud genus shall be reported as missing and the cloud height shall be replaced by vertical visibility.

Note: The vertical visibility is defined as the vertical visual range into an obscuring medium.

12.4.10.6 Cloud heights are the « height above surface ». This shall be considered as being the height above the official aerodrome elevation or above station level at a non-aerodrome station. If two or more types of cloud occur with their bases at the same level and this level is one to be reported in accordance with Regulation 12.4.10.1, the selection for cloud genus and amount shall be made with the following criteria :

(a) If these types do not include Cumulonimbus then cloud genus shall refer to the cloud type that represents the greatest amount, or if there are two or more types of cloud all having the same amount, the highest applicable code figure for cloud genus shall be reported. Cloud amount shall refer to the total amount of cloud whose bases are all at the same level ;

(b) If these types do include Cumulonimbus then one group shall be used to describe only this type with cloud genus reported as Cumulominbus and the cloud amount as the amount of the Cumulonimbus. If the total amount of the remaining type(s) of cloud (excluding Cumulonimbus) whose bases are all at the same level is greater than that required by Regulation 12.4.10.1, then another group shall be reported with genus being selected in accordance with (a) and amount referring to the total amount of the remaining cloud (excluding Cumulonimbus).

12.4.10.7 Regulations 12.2.2.2.3 to 12.2.2.2.6, inclusive shall apply.

Clouds with bases below station level

This part is not consistent with the system used in the rest of the text:
Reporting of clouds with bases below station level is described using a mixture of BUFR sequence descriptors and SYNOP groups and symbolic letters.

Inclusion of these data shall be determined by national decision.

12.5.2 Clouds with tops below station level shall be reported only by ~~these descriptors~~ sequence 3 02 036, and any co-existent clouds with bases above station level shall be reported *in Sequences 3 02 004 and 3 02 005.*

12.5.3 Low clouds with bases below and tops above station level shall be reported in ~~both~~ *Sequences 3 02 004, 3 02 005 and 3 02 036*, provided that the station is out of cloud sufficiently frequently to enable the various features to be recognized. In this case :

(a) N_h shall correspond with N' and C_L with C' while h shall be coded as missing *or having a negative value if the base of cloud is observed*;

(b) If the upper surface of clouds with tops above station level can be observed, it shall be reported with H'H';

(c) Other low clouds present with tops below station level shall be reported in a second N'C'H'H'C_t cloud group;

12.5.3.1 Each cloud group reported in Sequence 3 02 036 shall have the following parameters:

(a) Vertical significance
(b) Amount of cloud whose base is below the level of the station;
(c) Genus of cloud whose base is below the level of the station;
(d) Altitude of the upper surface of clouds below the level of the station;
(e) Description of the top of cloud whose base is below the level of the station.

12.5.4 If the station is in almost continuous cloud, ~~*Sequence 3 02 036* shall be omitted~~ all parameters shall be reported as missing.

12.5.5 When two or more cloud layers with their bases below station level occur at different levels, two or more cloud groups shall be reported *in Sequence 3 02 036*.

12.5.6 Rapidly dissipating condensation trails shall not be reported in *Sequence 3 02 036.*

12.5.7 However, the top of persistent condensation trails and cloud masses which have obviously developed from condensation trails shall be reported in *Sequence 3 02 036*.

12.5.8 Regulations 12.2.2.2.1 to 12.2.2.2.6, inclusive shall apply.

12.5.9 Spaces occupied by mountains emerging from the cloud layers shall be counted as occupied by clouds

Direction of cloud drift

12.4.7.5 True direction, in degrees, from which the low, middle, or high clouds are moving.

Note :

This information is required from land stations mainly in the tropics.

Direction and elevation of cloud

12.4.7.1 True direction, in degrees, from which orographic clouds or clouds with vertical development are seen, and elevation angle, in degrees, of the top of the cloud with specified genus (Code table 0 20 012).

Note :

This information is required from land stations mainly in the tropics.

State of ground, snow depth, ground minimum temperature

State of ground (with or without snow), Code table 0 20 062.

Total snow depth, in meters (with precision in hundredths of a meter).

When total snow depth has to be reported, it is reported as 0.00 m if no snow, ice and other forms of solid precipitation on the ground are observed at the time of observation. A snow depth of - 0.01 m shall indicate a little (less than 0.005 m) snow. A snow depth of – 0.02 shall indicate “snow cover not continuous).

12.4.6.1 The measurement shall include snow, ice and all other forms of solid precipitation on the ground at the time of observation.

12.4.6.2 When the depth is not uniform, the average depth over a representative area shall be reported.

Ground minimum temperature**, in degrees Kelvin (with precision in hundredths of a degree Kelvin); if produced in CREX, in degrees Celsius (with precision in hundredths of a degree Celsius)**

The period of time covered by ground minimum temperature and the synoptic hour at which this temperature is reported shall be determined by regional decision.

Note:

Ground minimum temperature data shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

Basic synoptic “period” data

Present and past weather

12.2.6.1 **Present weather** (Code table 0 20 003) and **past weather** (Code tables 0 20 004 and 0 20 005) shall be included in an observation by a manually operated station after a period of closure or at start up, when past weather conditions for the period applicable to the report are unknown. ~~Otherwise, it shall only be included if present or past weather phenomena of significance, or both, were observed.~~ Present weather reported as missing shall indicate that present conditions are unknown. Past weather reported as missing shall indicate that previous conditions are unknown. This regulation shall also apply to automatic reporting stations with the facility to report present and past weather.

12.2.6.2 Code figures 0, 1, 2, 3 and 100 for present weather and code figures 0, 1, 2 and 10 for past weather shall be considered to represent phenomena without significance.

12.2.6.3 Present and past weather shall be *reported if available (observation made), regardless of their significance.* ~~omitted if both present and past weather were:~~

~~(a) Not available (no observation made); or~~

(b) ~~An observation was made but observed phenomena were not of significance~~

If data are produced and collected in TAC and present weather and past weather is omitted (no significant phenomenon to report), code figure 508 shall be used for present weather in BUFR or CREX.

Present weather from a manned weather station:

12.2.6.4.1 If more than one form of weather is observed, the highest applicable code figure from the range <00 to 99> shall be selected for present weather. ~~Other weather may be reported and repeated as necessary~~. Code figure 17 shall have precedence over code figures 20 – 49. Other weather may be reported using additional entries 0 20 021 to 0 20 026.

12.2.6.4.2 In coding 01, 02, or 03, there is no limitation on the magnitude of the change of the cloud amount. Code figures 00, 01, and 02 can each be used when the sky is clear at the time of observation. In this case, the following interpretation of the specifications shall apply:

- 00 is used when the preceding conditions are not known
- 01 is used when the clouds have dissolved during the past hour
- 02 is used when the sky has been continuously clear during the past hour

12.2.6.4.3 When the phenomena is not predominantly water droplets, the appropriate code figure shall be selected without regard to visibility,

12.2.6.4.4 The code figure 05 shall be used when the obstruction to vision consists predominantly of lithometeors.

12.2.6.4.5 National instructions shall be used to indicate the specifications for code figures 07 and 09.

12.2.6.4.6 The visibility restrictions on code figure 10 shall be 1000 metres or more. The specification refers only to water droplets and ice crystals.

12.2.6.4.7 For code figures 11 or 12 to be reported, the apparent visibility shall be less than 1000 metres.

12.2.6.4.8 For code figure 18, the following criteria for reporting squalls shall be used :

(a) When wind speed is measured : A sudden increase of wind speed of at least eight metres per second (16 knots), the speed rising to 11 metre per second (22 knots) or more and lasting for at lest one minute ;

(b) When the Beaufort scale is used for estimating wind speed : A sudden increase of wind speed by at least three stages of the Beaufort scale, the speed rising to force 6 or more and lasting for at least one minute.

12.2.6.4.9 Code figures 20 – 29 shall never be used when precipitation is observed at the time of observation.

12.2.6.4.10 For code figure 28, visibility shall have been less than 1000 metres.

Note : The specification refers only to visibility restrictions which occurred as a result of water droplets or ice crystals.

12.2.6.4.11 For synoptic coding purposes, a thunderstorm shall be regarded as being at the station from the time thunder is first heard, whether or not lightning is seen or precipitation is occurring at the station. A thunderstorm shall be reported if thunder is heard within the normal observational period preceding the time of the report. A thunderstorm shall be regarded as having ceased at the time thunder is lst heard and the cessation is confirmed if thunder is not heard for 10 – 15 minutes after this time.

12.2.6.4.12 The necessary uniformity in reporting code figures 36, 37, 38, and 39 which may be desirable within certain regions shall be obtained by means of national instructions.

12.2.6.4.13 A visibility restriction « less than 1000 metres » shall be applied to code figures 42 – 49. In the case of code figures 40 or 41, the apparent visibility in the fog or ice fog patch or bank shall be less than 1000 metres. Code figures 40 – 47 shall be used when the obstructions to vision consist predominantly of water droplets or ice crystals, and 48 or 49 when the obstructions consist predominantly of water droplets.

12.2.6.4.14 When referring to precipitation, the phrase « at the station » in the code table shall mean « at the point where the observation is normally taken ».

12.2.6.4.15 The precipitation shall be encoded as intermittent if it has been discontinuous during the preceding hour, without presenting the character of a shower.

12.2.6.4.16 The intensity of precipitation shall be determined by the intensity at the time of the observation.

12.2.6.4.17 Code figures 80 – 89 shall be used only when the precipitation is of the shower type and takes place at the time of the observation.

Note : Showers are produced by convective clouds. They are characterized by their abrupt beginning and end and by the generally rapid and sometimes great variations in the intensity of the precipitation. Drops and solid particles falling in a shower are generally larger than those falling in non-showery precipitation. Between showers openings may be observed unless stratiform clouds fill the intervals between the cumuliform clouds.

12.2.6.4.18 In reporting code figure 98, the observer shall be allowed considerable latitude in determining whether precipitation is or is not occurring, if it is not actually visible.

Present weather from an automatic weather station:

12.2.6.5.1 The highest applicable code figure shall be selected.

12.2.6.5.2 In coding code figures 101, 102, and 103, there is no limitation on the magnitude of the change of the cloud amount. Code figures 100, 101, and 102 can each be used when the sky is clear at the time of observation. In this case, the following interpretation of the specifications shall apply:

- Code figure 100 is used when the preceding conditions are not known ;
- Code figure 101 is used when the clouds have dissolved during the past hour ;
- Code figure 102 is used when the sky has been continuously clear during the past hour.

12.2.6.5.3 When the phenomenon is not predominantly water droplets, the appropriate code figure shall be selected without regard to the visibility.

12.2.6.5.4 The code figures 104 and 105 shall be used when the obstruction to vision consists predominantly of lithometeors.

12.2.6.5.5 The visibility restriction on code figure 110 shall be 1000 metres or more. The specification refers only to water droplets and ice crystals.

12.2.6.5.6 For code figure 118, the following criteria for reporting squalls shall be used : A sudden increase of wind speed of at least eight metres per second (16 knots), the speed rising to 11 metres per second (22 knots) or more and lasting for at least one minute.

12.2.6.5.7 Code figures 120 – 126 shall never be used when precipitation is observed at the time of observation.

12.2.6.5.8 For code figure 120, visibility shall have been less than 1000 metres.

Note : The specification refers only to visibility restrictions which occurred as a result of water droplets or ice crystals.

12.2.6.5.9 For synoptic coding purposes, a thunderstorm shall be regarded as being at the station from the time thunder is first detected, whether or not lightning is detected or precipitation is occurring at the station. A thunderstorm shall be reported in present weather if thunder is detected within the normal observational period preceding the time of the report. A thunderstorm shall be regarded as having ceased at the time thunder is last detected and the cessation is confirmed if thunder is not detected for 10 – 15 minutes after this time.

12.2.6.5.10 A visibility restriction « less than 1000 metres » shall be applied to code figures 130 – 135.

12.2.6.5.11 The precipitation shall be encoded as intermittent if it has been discontinuous during the preceding hour, without presenting the character of a shower.

12.2.6.5.12 The intensity of predipitation shall be determined by the intensity at the time of observation.

12.2.6.5.13 Code figures 180 – 189 shall be used only when the precipitation is intermittent or of the shower type and takes place at the time of observation.

Note : Showers are produced by convective clouds. They are characterized by their abrupt beginning and end and by the generally rapid and sometimes great variations in the intensity of the precipitaiton. Drops and solid particles falling in a shower are generally larger than those falling in non-showery precipitaiton. Between showers openings may be observed ujnless stratiform couds fill the intervals between the cumuliform clouds.

Past weather reported from a manned weather station:

12.2.6.6.1 The period (in hours) covered by past weather (1) and past weather (2) shall be:
(a) Six hours for observations at 0000, 0600, 1200, and 1800 UTC;
(b) Three hours for observations at 0300, 0900, 1500, and 2100 UTC;
(c) Two hours for intermediate observations if taken every two hours.
(d) *One hour for intermediate observations if taken every hour*.

12.2.6.6.2 The code figures for past weather (1) and past weather (2) shall be selected in such a way that past and present weather together give as complete a description as possible of the weather in the time interval concerned. For example, if the type of weather undergoes a complete change during the time interval concerned, the code figures selected for past weather (1) and past weather (2) shall describe the weather prevailing before the type of weather indicated by present weather began.

12.2.6.6.3 When the past weather (1) and past weather (2) are used in hourly reports other than those covered by Regulation 12.2.12.6.1 (a) and (b), they cover a short period of time and Regulation 12.2.12.6.2 shall apply.

12.2.6.6.4 If, using Regulation 12.2.12.6.2, more than one code figure may be given to past weather (1), the highest figure shall be reported for past weather (1) and the second highest code figure shall be reported for past weather (2).

12.2.6.6.5 If the weather during the period has not changed so that only one code figure may be selected for past weather, then that code figure shall be reported for both past weather (1) and past weather (2).

Past weather from an automatic weather station:

12.2.6.7.1 The period (in hours) covered by past weather (1) and past weather (2) shall be:
(a) Six hours for observations at 0000, 0600, 1200, and 1800 UTC;
(b) Three hours for observations at 0300, 0900, 1500, and 2100 UTC;
(c) Two hours for intermediate observations if taken every two hours.
(d) One hour for intermediate observations if taken every hour.

12.2.6.7.2 The code figures for past weather (1) and past weather (2) shall be selected so that the maximum capability of the automatic station to discern past weather is utilized, and so that past and present weather together give as complete a description as possible of the weather in the time interval concerned.

12.2.6.7.3 In cases where the automatic station is capable only of discerning very basic weather conditions, the lower code figures representing basic and generic phenomena may be used. If the automatic station has higher discrimination capabilities, the higher code figures representing more detailed explanation of the phenomena shall be used. For each basic type of phenomenon, the highest code figure within the discrimination capability of the automatic station shall be reported.

12.2.6.7.4 If the type of weather during the time interval concerned undergoes complete and discernible changes, the code figures selected for past weather (1) and past weather (2) shall describe the weather prevailing before the type of weather indicated by present weather began. The highest figure shall be reported for past weather (1) and the second highest code figure shall be reported for past weather (2).

12.2.6.7.5 If a discernible change in weather has not occurred during the period, so that only one code figure may be selected for the past weather, then that code figure shall be reported for both past weather (1) and past weather (2). For example, rain during the entire period shall be reported as code figure 14 for both past weather (1) and past weather (2) in the case of an automatic station incapable of differentiating types of precipitation, or code figure 16 for both past weather (1) and past weather (2) in the case of a station with the higher discrimination capability.

Sunshine data

Period of reference for sunshine duration **(in hours).**

Duration of sunshine over the previous hour and over the previous 24 hours may be reported.

Duration of sunshine (in minutes).

The duration of sunshine over the previous hour shall be reported by national decision.

12.4.7.4.2 The duration of sunshine over the previous 24 hours shall, by regional decision, be reported at all stations capable of doing so and included at either 0000 UTC, 0600 UTC, 1200 UTC or 1800 UTC. ~~When the duration of sunshine is reported, it is accompanied by the absolute value of the amount of solar or terrestrial radiation, as appropriate, in joules per square centimetre over the previous 24 hours at either 0000 UTC, 0600 UTC, 1200 UTC, or 1800 UTC.~~

Precipitation measurement

Height of sensor above local ground (for precipitation measurement), in meters (with precision in hundredths of a meter)

This datum represents the actual height of the rain gauge rim above ground at the point where the rain gauge is located.

Period of reference for amount of precipitation**, ending at the time of observation (in hours) shall be determined by regional decision.**

~~*Amount of precipitation which has fallen during the period of reference, and duration of period of reference for amount of precipitation, ending at the time of the report.*~~

Total amount of precipitation, in kilograms per square meter (with precision in tenths of a kilograms per square meter) which has fallen during the period of reference for amount of precipitation.

12.2.5.4 Precipitation, when it can be and has to be reported, shall be ~~coded 0~~ reported as 0.0 kgm^{-2} ~~even~~ if no precipitation were observed during the referenced period. Trace shall be reported as - 0.1 kgm^{-2}.

Extreme temperature data

Height of sensor above local ground (for temperature measurement), in meters (with precision in hundredths of a meter)

This datum represents the actual height of temperature sensor(s) above ground at the point where the sensors are located.

Period of reference for extreme temperatures **(in hours) shall be determined by regional decision.**

12.4.4 **Maximum and minimum temperature**, ~~in tenths of a degree Celsius~~ in degrees Kelvin (with precision in hundredths of a degree Kelvin); if produced in CREX, in degrees Celsius (with precision in hundredths of a degree Celsius). The ~~period of time covered by the maximum and minimum temperature and the~~ synoptic hour at which these temperatures are reported shall be determined by regional decision.

Note:

Extreme temperature data shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values.

Wind data

Height of sensor above local ground (for wind measurement), in meters (with precision in hundredths of a meter)

This datum represents the actual height of the sensor above ground at the point where the sensor is located.

12.2.2.3.1 **Wind direction** is the true direction, in ~~tens of~~ degrees, from which the wind is blowing ~~(or will blow)~~ and **wind speed**, in ~~either~~ metres per second (with precision in tenths of meters per second) ~~or knots~~. The mean direction and speed of the wind over the 10-minute period immediately preceding the observation shall be reported. However, when the 10-minute period includes a discontinuity in the wind characteristics, only data obtained after the discontinuity shall be used for reporting the mean values, and hence the period in these circumstances shall be correspondingly reduced.

12.2.2.3.2 In the absence of wind instruments, the wind speed shall be estimated on the basis of the Beaufort wind scale. The Beaufort number obtained by estimation is converted into metres per second by use of the wind speed equivalent columns on the Beaufort scale, and this speed is reported for wind speed.

Period of reference for wind gust direction and speed (in hours) shall be determined by regional or national decision. If it is reported, maximum wind gust direction in degrees true and maximum wind gust speed in metres per second (with precision in tenths of meters per second).

Evaporation data

12.4.7.2.2 Amount of either **evaporation or evapotranspiration**, in kilograms per square meter (with precision in tenths of a kilogram per square meter), during the preceding 24 hours, and indicator of type of instrument for evaporation measurement or the type of crops, at either 0000 UTC, 0600 UTC, or 1200 UTC.

Radiation data

Period of reference for radiation data (in hours).

Radiation over the previous hour and over the previous 24 hours may be reported.

Amount of radiation, in joules per square metre (with precision in thousandths of a joule per square metre for radiation type (1) and (2); with precision in ten-thousandths of a joule per square metre for radiation types (3) to (6)).

12.4.7.4.3 The radiation data may take one or more of the following forms:

(1) Long-wave radiation (using the proper sign to specify downward or upward long-wave radiation);
(2) Short-wave radiation;
(3) Net radiation (using the proper sign to specify positive or negative net radiation);
(4) Global solar radiation;
(5) Diffuse solar radiation;
(6) Direct solar radiation.

The above regulation covers SYNOP regulation 12.4.7.4.3 as well as 12.4.7.4.4.

Temperature change

Period of reference for temperature change (in hours)

12.4.4.1 The temperature change data during the period covered by past weather(1) and past weather(2). The temperature change ~~(see Code table 0822)~~ is for the period of time, in hours, between the time of the observation and the time of the occurrence of temperature change. To construct the required period, time period or displacement has to be included twice; the first one corresponding to period covered by past weather (1) and past weather (2), the second one specified by the time of the occurrence of temperature change.

Note:
The period is the number of whole hours, disregarding the minutes. For example, if the time of occurrence is 45 minutes after the time of the observation, the time period is considered to be zero hours. If the time of occurrence is 1 hour or more, but less than 2 hours after the observation, the time period go shall be considered to be 1 hour, etc.

Temperature change in degrees (Kelvin or Celsius)

12.4.7.2 For a change of temperature to be reported, the change shall be equal to or more than 5° C and occur in less than 30 minutes during the period covered by past weather (1) and past weather (2).

Note:
The reporting of this information is restricted by regional or national decision to islands or other widely separated stations.

ANNEX TO PARAGRAPH 5.2

REGIONAL PRACTICES

1. For regional practices, the existing global template for SYNOP data are supplemented by relevant additions, reflecting the reporting practices in the particular Regional Association (RA). Coverage of regional reporting practices in BUFR templates for PILOT and TEMP data is discussed in paragraph 5 and 6 of this Annex.

2. List of SYNOP (Section 3) groups to be expressed in the regional templates for SYNOP data

RA I

- group $0T_gT_gR_cR_t$ (ground minimum temperature of the preceding night; character and intensity of precipitation; time of beginning or end of precipitation),
- groups 80000 $0L_nL_cL_dL_g$ $1s_Ld_LD_Lv_e$ (locust control related observation).

RA II

- group $0Es_nT'_gT'_g$ (state of ground, ground temperature at the time of observation);
- group $3Es_nT_gT_g$ (ground minimum temperature of the preceding night).

RA III

- group $3Es_nT_gT_g$ (ground minimum temperature of the preceding night).

RA IV

- group $0C_s$ $D_LD_MD_H$ (state of sky in tropics, direction of cloud drift)
- additional groups: “TORNADO”, “ONE-MINUTE MAXIMUM ... KNOTS AT ... UTC”, etc.

RA VI

- group 96119 (tornado cloud (destructive)),
- group $919M_WD_a$ (type of water spout, tornado, whirlwind, dustdevils and direction from which they approach the station),
- group $918s_qD_p$ (type of squall and direction from which it approaches the station),
- groups $9298S'_8$ and $9299S'_8$ (drifting and blowing snow),
- group 932RR (maximum diameter of hailstones),
- groups 934RR, 935RR, 936RR and 937RR (diameter of frozen deposit).

3. Proposal for new descriptors, code tables and additions to existing tables

3.1 Proposed new descriptors:

F X Y	Element name	BUFR				CREX		
0 12 121	Ground minimum temperature	K	2	0	16	°C	2	4
0 12 122	Ground minimum temperature of the preceding night	K	2	0	16	°C	2	4
0 13 056	Character and intensity of precipitation	Code table	0	0	4	Code table	0	2
0 13 057	Time of beginning or end of precipitation	Code table	0	0	4	Code table	0	2
0 20 028	Evolution of drift of snow	Code table	0	0	4	Code table	0	2
0 20 055	State of sky in tropics	Code table	0	0	4	Code table	0	2

0 20 066	Maximum diameter of hailstones	m	3	0	8	m	3	3
0 20 067	Diameter of deposit	m	3	0	9	m	3	3
0 20 101	Locust (acridian) name	Code table	0	0	4	Code table	0	2
0 20 102	Locust (maturity) color	Code table	0	0	4	Code table	0	2
0 20 103	Stage of development of locusts	Code table	0	0	4	Code table	0	2
0 20 104	Organization state of swarm or band of locusts	Code table	0	0	4	Code table	0	2
0 20 105	Size of swarm or band of locusts and duration of passage of swarm	Code table	0	0	4	Code table	0	2
0 20 106	Locust population density	Code table	0	0	4	Code table	0	2
0 20 107	Direction of movements of locust swarm	Code table	0	0	4	Code table	0	2
0 20 108	Extent of vegetation	Code table	0	0	4	Code table	0	2

Moreover, it is proposed to rename descriptor **0 20 054** "True direction from which clouds are moving" to read "**True direction from which a phenomenon or clouds are moving**" to allow its usage for data representation of groups $919M_WD_a$ (type of water spout, tornado, whirlwind, dustdevils and direction from which they approach the station) and $918s_qD_p$ (type of squall and direction from which it approaches the station).

3.2 Proposed new Code tables:

		Manual on Codes, WMO-No.306, Vol. II
0 - 13 056	Character and intensity of precipitation	Code table 167
0 - 13 057	Time of beginning or end of precipitation	Code table 168
0 - 20 055	State of sky in tropics	Code table 430
0 - 20 101	Locust (acridian) name	Code table 162
0 - 20 102	Locust (maturity) color	Code table 159
0 - 20 103	Stage of development of locusts	Code table 160
0 - 20 104	Organization state of swarm or band of locusts	Code table 161
0 - 20 105	Size of swarm or band of locusts and duration of passage of swarm	Code table 173
0 - 20 106	Locust population density	Code table 139
0 - 20 107	Direction of movements of locust swarm	Code table 140
0 20 108	Extent of vegetation	Code table 182

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The existing extent of the above listed Code tables from Manual on Codes, WMO-No. 306, Volume II, is to be supplemented by code figures 10-14 Reserved and by code figure15 Missing value.

Code Table 0 20 028 is proposed to express code figures for S'_8 (Code table 3776, Manual on Codes, WMO-No. 306, Volume I.1).

0 20 028
Evolution of drift of snow

Code figure	
0	Drift snow ended before the hour of observation
1	Intensity diminishing
2	No change
3	Intensity increasing
4	Continues, apart from interruption lasting less than 30 minutes
5	General drift snow has become drift snow near the ground
6	Drift snow near the ground has become general drift snow
7	Drift snow has started again after an interruption of more than 30 minutes
8 -14	Reserved
15	Missing value

3.3 Proposed additions to the existing Flag tables:

0 20 023

Bit No.	**Other weather phenomena**
12	Water-spout

0 20 027

Bit No.	**Phenomenon occurrence**
6	Below station level

0 08 042

Bit No.	**Extended vertical sounding significance**
15	Level determined by regional decision

4. Proposal for regional templates for SYNOP data

The **global BUFR template for SYNOP data**, shown in document ET DR&C/Doc. 5.4(1), may be expressed concisely as follows:

3 07 080		**Sequence for representation of synoptic reports from a fixed land station suitable for SYNOP data**
3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates
3 02 031		Pressure data
3 02 035		Basic synoptic “instantaneous” data
3 02 036		Clouds with bases below station level
3 02 047		Direction of cloud drift
0 08 002		Vertical significance (= missing to cancel the previous value)
3 02 048		Direction and elevation of cloud
3 02 037		State of ground, snow depth, ground minimum temperature
3 02 043		Basic synoptic “period” data

3 02 044		Evaporation data
1 01 002		Replicate next descriptor 2 times
3 02 045		Radiation data (from 1 hour and/or 24 hour period)
3 02 046		Temperature change

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA I

It is proposed to represent this template by a descriptor 3 07 081.

3 07 081:

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	Unit, scale
3 02 031		Pressure data	
3 02 035		Basic synoptic "instantaneous" data	
3 02 036		Clouds with bases below station level	
3 02 047		Direction of cloud drift	
0 08 002		Vertical significance (= missing to cancel the previous value)	Code table, 0
3 02 048		Direction and elevation of cloud	
3 02 037		State of ground, snow depth, ground minimum temperature (past 12 hours)	
0 12 122		**Ground minimum temperature of the preceding night $s_nT_gT_g$**	K, 2
0 13 056		**Character and intensity of precipitation R_c**	Code table, 0
0 13 057		**Time of beginning or end of precipitation R_t**	Code table, 0
0 20 101		**Locust (acridian) name L_n**	Code table, 0
0 20 102		**Locust (maturity) color L_c**	Code table, 0
0 20 103		**Stage of development of locusts L_d**	Code table, 0
0 20 104		**Organization state of swarm or band of locusts L_g**	Code table, 0
0 20 105		**Size of swarm or band of locusts and duration of passage of swarm s_L**	Code table, 0
0 20 106		**Locust population density d_L**	Code table, 0
0 20 107		**Direction of movements of locust swarm D_L**	Code table, 0
0 20 108		**Extent of vegetation v_e**	Code table, 0
3 02 043		Basic synoptic "period" data	
3 02 044		Evaporation data	
1 01 002		Replicate next descriptor 2 times	
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	
3 02 046		Temperature change	

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA II

It is proposed to represent this template by a descriptor 3 07 082.

3 07 082:

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	Unit, scale
3 02 031		Pressure data	
3 02 035		Basic synoptic "instantaneous" data	
3 02 036		Clouds with bases below station level	
3 02 047		Direction of cloud drift	
0 08 002		Vertical significance (= missing to cancel the previous value)	Code table, 0
3 02 048		Direction and elevation of cloud	
3 02 037		State of ground, snow depth, ground minimum temperature (past 12 hours)	
0 12 121		**Ground minimum temperature** (at the time of observation) **$s_nT'_gT'_g$**	K, 2
0 12 122		**Ground minimum temperature of the preceding night $s_nT_gT_g$**	K, 2
3 02 043		Basic synoptic "period" data	
3 02 044		Evaporation data	
1 01 002		Replicate next descriptor 2 times	
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	
3 02 046		Temperature change	

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA III

It is proposed to represent this template by a descriptor 3 07 083.

3 07 083:

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	Unit, scale
3 02 031		Pressure data	
3 02 035		Basic synoptic "instantaneous" data	
3 02 036		Clouds with bases below station level	
3 02 047		Direction of cloud drift	
0 08 002		Vertical significance (= missing to cancel the previous value)	Code table, 0
3 02 048		Direction and elevation of cloud	
3 02 037		State of ground, snow depth, ground minimum temperature (past 12 hours)	
0 12 122		**Ground minimum temperature of the preceding night $s_nT_gT_g$**	K, 2
3 02 043		Basic synoptic "period" data	
3 02 044		Evaporation data	
1 01 002		Replicate next descriptor 2 times	
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	
3 02 046		Temperature change	

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA IV

It is proposed to represent this template by a descriptor 3 07 084.

3 07 084:

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	Unit, scale
3 02 031		Pressure data	
3 02 035		Basic synoptic “instantaneous” data	
3 02 036		Clouds with bases below station level	
0 20 055		**State of sky in tropics** **C_S**	Code table, 0
3 02 047		Direction of cloud drift	
0 08 002		Vertical significance (= missing to cancel the previous value)	Code table, 0
3 02 048		Direction and elevation of cloud	
3 02 037		State of ground, snow depth, ground minimum temperature (past 12 hours)	
2 05 YYY		**Additional information of YYY characters**	CCITT IA5, 0
3 02 043		Basic synoptic “period” data	
3 02 044		Evaporation data	
1 01 002		Replicate next descriptor 2 times	
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	
3 02 046		Temperature change	

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA V

No regional practices are indicated in Manual on Codes, WMO-No. 306, Volume II. Thus the RA V template is identical with the global BUFR template for SYNOP data (see ET DR&C/Doc. 5.4(1)). Nevertheless, a sequence descriptor number (**3 07 085**) is proposed to be reserved for a BUFR sequence for representation of SYNOP data in compliance with reporting practices in RA V, should they be developed in the future.

BUFR template for synoptic reports from fixed land stations suitable for SYNOP data in compliance with reporting practices in RA VI

It is proposed to represent this template by a descriptor 3 07 086.

3 07 086:

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	Unit, scale
3 02 031		Pressure data	
3 02 035		Basic synoptic “instantaneous” data	
3 02 036		Clouds with bases below station level	
0 08 002		Vertical significance (= missing to cancel the previous value)	
3 02 037		State of ground, snow depth, ground minimum temperature	
3 02 066		**Dangerous weather phenomena**	
		Groups 919M_WD_a and 96119 in SYNOP	
	0 20 023	**Other weather phenomena** M_W (1= Dust/sand whirl, 9= Funnel clouds not touching surface, 10 = Funnel clouds touching surface, 12 = Water-spout)	Flag table, 0
	0 20 024	**Intensity of phenomena** (1= Light, 2 = Moderate, 3 = Heavy, 4 = Violent)	Code table, 0
	0 20 027	**Phenomenon occurrence** (1=At time of observation, 3=In time period for past weather)	Flag table, 0
	0 20 054	**True direction from which a phenomenon or clouds are moving** D_a	Degree true, 0
		Group 918s_qD_p in SYNOP	
	0 20 023	**Other weather phenomena** (2 = Squalls) s_q	Flag table, 0
	0 20 027	**Phenomenon occurrence** (1=At time of observation, 3=In time period for past weather)	Flag table, 0
	0 20 054	**True direction from which a phenomenon or clouds are moving** D_p	Degree true, 0
		Group 929$S_8S'_8$ in SYNOP	
	0 20 025	**Obscuration** (13 = Snow)	Flag table, 0
	0 20 026	**Character of obscuration** (5= Low drifting, 6= Blowing) S_8	Code table, 0
	0 20 027	**Phenomenon occurrence** (1=At time of observation, 3=In time period for past weather)	Flag table, 0
	0 20 028	**Evolution of drift of snow** S'_8	Code table, 0
		Group 932RR	
	0 20 066	**Maximum diameter of hailstones** RR	m, 3
	0 20 027	**Phenomenon occurrence** (1=At time of observation, 3=In time period for past weather)	Flag table, 0
		Groups 934RR- 937RR in SYNOP	
	0 20 021	**Type of precipitation** (15=Glaze, 16=Rime, 20=Wet snow)	Flag table, 0
	0 20 027	**Phenomenon occurrence** (1=At time of observation, 3=In time period for past weather)	Flag table, 0
	0 20 067	**Diameter of deposit** RR	m, 3
3 02 043		Basic synoptic “period” data	
3 02 044		Evaporation data	
1 01 002		Replicate next descriptor 2 times	
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	

Note:
Groups $56D_LD_MD_H$, $57CD_ae_C$ and $54g_0s_nd_T$ are not used in RA VI and therefore the corresponding sequence descriptors 3 02 047, 3 02 048 and 3 02 046 are not included in the RA VI regional template for SYNOP data.

5. Coverage of regional coding procedures in BUFR templates for PILOT type data

Regional coding procedures for PILOT and PILOT SHIP require reporting wind data at additional levels as specified by the regional regulations in Manual on Codes, WMO-No. 306, Volume II. The current BUFR templates for PILOT and PILOT SHIP data (see ET DR&C/Doc. 5.4(1)) are capable to accommodate data at these additional levels, i.e. no modification of these templates is needed. These levels can be identified by a new entry (bit No. 15 = Level determined by regional decision) in 0 08 042 - Extended vertical sounding significance as proposed in paragraph 3.3.

6. 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 (see ET DR&C/Doc. 5.4(1)) 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).

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 $101A_{df}A_{df}$. Some further additions will be needed, e.g. for stability index.

3 09 052		**Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data**	
		to be supplemented by:	
		Reason for no report or incomplete report	
0 35 035		Reason for termination	Code table, 0
		Doubtful data	
1 09 000		Delayed replication of 9 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric
0 04 086		Long time period or displacement (since launch time)	Second
0 08 042		Extended vertical sounding significance	Flag 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
2 04 001		Add associated field of 1 bit in length	
0 31 021		Associated field significance = 1 (indicator of quality)	Code table, 0
		Associated field set to 1 (suspect or bad)	
0 10 009		Geopotential height	gpm
2 04 000		Cancel Add associated field	
1 09 000		Delayed replication of 9 descriptors	
0 31 001		Delayed descriptor replication factor	Numeric
0 04 086		Long time period or displacement (since launch time)	Second
0 08 042		Extended vertical sounding significance	Flag 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
2 04 001		Add associated field of 1 bit in length	
0 31 021		Associated field significance = 1 (indicator of quality)	Code table, 0
		Associated field set to 1 (suspect or bad)	
0 12 101		Temperature/dry-bulb temperature (scale 2)	K, scale 2
2 04 000		Cancel Add associated field	
		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, 0
3 03 054		Temperature, dew-point, wind at a pressure level with radiosonde position	
2 04 000		Cancel Add associated field	

ANNEX TO PARAGRAPH 5.3

1. Background

The BUFR templates for Traditional Alphanumeric Codes (TAC) data submitted in ET DR&C/Doc. 5.4(1) provide facilities for data representation of the corresponding traditional codes described in the international part of Manual on Codes, WMO-No. 306, Volume I.1 (with a few exceptions mentioned in that document). Coverage of regional coding procedures related to TAC described in Manual on Codes, WMO-No. 306, Volume II [2], has been proposed in ET DR&C/Doc. 5.2(1).

2. National reporting practices

To make migration to Table Driven Code Forms complete, also the coverage of national reporting practices published in [2] has to be considered. Although the list of national reporting practices in [2] is of significant size, implementation of them should not cause any major problems. A great number of the announced national practices deals with specification of time or period to which the reported value is related (in SYNOP national regulations), or contain information on not reporting specified items, e.g. CAVOK or groups WS TKOF RWYD_RD_R , WS LDG RWYD_RD_R in METAR/SPECI.

Some of the national reporting practices announced in [2] are already covered by the additional entries, reflecting the reporting practices in the particular region, e.g. Russian Federation reports the group $S_PS_Ps_ps_p$ in accordance with regulation 6/12.12.2, which is exhaustively covered by the set of element descriptors represented by 3 02 066 (Dangerous weather phenomena) that has been proposed in CT MTDCF/Doc. 5.1(2) and ET DR&C/Doc. 5.2(1). The same applies to Spain (Canary Islands), although they are listed in RA I. If the required data representation is not available in the BUFR regional template for the particular region, it may be available in an other one. Inclusion of plain language information is mentioned few times in the national coding procedures, e.g. required by Madagascar for CLIMAT TEMP reports. This could be solved by inclusion of 2 05 YYY (Additional information of YYY characters).

Representation of other national procedures may be accomplished by supplementing the existing global or regional BUFR templates by relevant additions, using the entries available in the BUFR Tables. For example, several states in RA VI (Austria, Czech Republic, France, Slovakia, Switzerland) have announced reporting the depth of fresh snow in the group 931ss in SYNOP. This information may be expressed by inclusion of 0 13 012 (Depth of fresh snow) being preceded by 0 04 024 (Time period or displacement in hours), expressing the time period to which the newly fallen snow is related (either period W_1W_2 or the period specified by 907tt in SYNOP).

Data representation of the content of SYNOP Section 5 in BUFR is another item to be discussed. The use of this section is determined by national decision and it is usually cut off prior to international distribution, if not required for the exchange by regional or bilateral arrangements. The representation of Section 5 data in BUFR might not be needed, if this information is not required for international exchange, especially at the stage of migration when the data are collected in SYNOP at the national level and converted to BUFR (or CREX) in the centre. To make the migration complete, however, the data should be produced in TDCF at the observation sites and thus attention should be paid also to the representation of these data in BUFR. An example is shown in paragraph 3 below.

It might be recommended to encourage the national data representation experts to supplement existing BUFR templates by necessary additions for representation of the complete extent of data in compliance with relevant global, regional and national requirements. Members of the Expert Team on Data Representation and Codes may provide advice and suggestions in solving the actual problems, if any.

3. Example of a national template for SYNOP data (Czech Republic)

Czech SYNOP stations report the following groups, if appropriate.

Group $S_PS_Ps_ps_p$ is used in the forms:

- $919M_WD_a$ (type of water spout, tornado, whirlwind, dustdevils and direction from which they approach the station),
- $9298S'_8$ and $9299S'_8$ (drifting and blowing snow),
- 932RR (maximum diameter of hailstones),
- 934RR, 935RR, 936RR and 937RR (diameter of frozen deposit),
- 90710 931ss (depth of fresh snow fallen during the preceding one hour),
- $951N_v/$ (fog in valleys or plains, observed from a station at a higher level),
- 96048 and 96049 (freezing fog observed simultaneously with precipitation phenomena).

Section 5 is used in the following form

555			
	$1d_sd_sf_sf_s$	$2f_{sm}f_{sm}f_{sx}f_{sx}$	3UU//
	$5s_nT_5T_5T_5$	$6s_nT_{10}T_{10}T_{10}$	$7s_nT_{20}T_{20}T_{20}$
	$8s_nT_{50}T_{50}T_{50}$	$9s_nT_{100}T_{100}T_{100}$	

to report
- Wind direction and speed from tower measurement in the group $1d_sd_sf_sf_s$,
- Maximum wind gust speed over 10 minute period and the period W_1W_2 in the group $2f_{sm}f_{sm}f_{sx}f_{sx}$,
- Relative humidity in the group 3UU//,
- Soil temperatures at the depths of 5, 10, 20, 50 and 100 cm in the groups $5s_nT_5T_5T_5$, $6s_nT_{10}T_{10}T_{10}$, $7s_nT_{20}T_{20}T_{20}$, $8s_nT_{50}T_{50}T_{50}$ and $9s_nT_{100}T_{100}T_{100}$.

BUFR template for SYNOP data from the Czech Republic

3 01 090		Fixed surface station identification, time, horizontal and vertical coordinates	**GLOBAL**
3 02 031		Pressure data	**GLOBAL**
3 02 035		Basic synoptic "instantaneous" data	**GLOBAL**
3 02 036		Clouds with bases below station level	**GLOBAL**
0 08 002		Vertical significance (= missing to cancel the previous value)	**GLOBAL**
3 02 037		State of ground, snow depth, ground minimum temperature	**GLOBAL**
		Soil temperatures	
1 01 005		Replicate one descriptor five times	**NATIONAL SECTION 5**
3 07 063	0 07 061	Depth below land surface **(= 5, 10, 20, 50 and 100)**	
	0 12 130	Soil temperature (scale 2)	
3 02 066		**Dangerous weather phenomena**	**REGIONAL**
		Groups $919M_WD_a$ and 96119 in SYNOP	
	0 20 023	Other weather phenomena (1= Dust/sand whirl, 9= Funnel clouds not touching surface, 10 = Funnel clouds touching surface, 12 = Water-spout)	
	0 20 024	Intensity of phenomena (1= Light, 2 = Moderate, 3 = Heavy, 4 = Violent)	**REGIONAL**
	0 20 027	Phenomenon occurrence (1=At time of observation, 3=In time period for past weather)	
	0 20 054	True direction from which a phenomenon or clouds are moving	

		Group $918s_qD_p$ in SYNOP	NOT USED
	0 20 023	Other weather phenomena (2 = Squalls)	
	0 20 027	Phenomenon occurrence (1=At time of observation, 3=In time period for past weather)	
	0 20 054	True direction from which a phenomenon or clouds are moving	
		Groups $951N_v$/, 96048, 96049, 9298S'$_8$ and 9299S'$_8$ in SYNOP	**REGIONAL** and **NATIONAL**
	0 20 025	Obscuration (**1= Fog**, 13 = Snow)	
	0 20 026	Character of obscuration (**2 = Patches, 4 = Freezing**, 6 = Blowing, **11 = Dense**)	
	0 20 027	Phenomenon occurrence (1=At time of observation, 3=In time period for past weather, **6 = Below station level**)	
	0 20 028	Evolution of drift of snow	
		Group 932RR	**REGIONAL**
	0 20 066	Maximum diameter of hailstones	
	0 20 027	Phenomenon occurrence (1=At time of observation, 3=In time period for past weather)	
		Groups 934RR- 937RR in SYNOP	**REGIONAL**
	0 20 021	Type of precipitation (15=Glaze, 16=Rime, 20=Wet snow)	
	0 20 027	Phenomenon occurrence (1=At time of observation, 3=In time period for past weather)	
	0 20 067	Diameter of deposit	
3 02 043		Basic synoptic "period" data	**GLOBAL**
3 02 044		Evaporation data	**GLOBAL**
1 01 002		Replicate next descriptor 2 times	**GLOBAL**
3 02 045		Radiation data (from 1 hour and/or 24 hour period)	**GLOBAL**
		Groups 90710 931ss in SYNOP	**NATIONAL**
0 04 024		Time period in hours **(= 1)**	
0 13 012		Depth of fresh snow	
		Wind data from tower measurement	**NATIONAL** **SECTION 5**
3 01 021	0 05 001	Latitude (high accuracy) **(of the tower location)**	
	0 06 001	Longitude (high accuracy) **(of the tower location)**	
0 07 030		Height of station ground above mean sea level **(of the tower location)**	
3 02 042	0 07 032	Height of sensor above local ground **(for tower wind measurement)**	
	0 02 002	Type of instrumentation for wind measurement	
	0 08 021	Time significance (= 2 (time averaged))	
	0 04 025	Time period (= - 10 minutes)	
	0 11 001	Wind direction **(from tower measurement)**	
	0 11 002	Wind speed **(from tower measurement)**	
	0 08 021	Time significance (= missing value)	
	1 03 002	Replicate next 3 descriptors 2 times	
	0 04 025	Time period in minutes	
	0 11 043	Maximum wind gust direction **(from tower measurement)**	
	0 11 041	Maximum wind gust speed **(from tower measurement)**	

ANNEX TO PARAGRAPH 5.4.1

LISTING OF TEMPLATES

The templates can be found in the WMO web server.

1. BUFR/CREX templates for common code data

BUFR/CREX templates for:

2. BUFR/CREX templates for maritime code data

BUFR/CREX templates for:

3. BUFR/CREX templates for aviation code data

BUFR/CREX templates for:

4. BUFR/CREX templates for satellite observations

BUFR/CREX templates for:

5. BUFR/CREX templates for miscellaneous codes

BUFR/CREX templates for:

Notes:

The VOS template page 23 is still for validation.

Page 31 3 15 003 TESAC will be changed by template provided by Etienne Charpentier.

3 15 004 no sequence define yet (at validation stage).

Template for TRACOB p. 33 3 08 010

Page 34, 35???

Pages 40 and 41, give other number for templates.

ANNEX TO PARAGRAPH 5.4.2

Sequence number required for all existing BUOY template 3 08 005 (see Annex to 5.4(1)REV **1**

Proposed BUFR Template for buoy and wave data
(draft)

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 (i.e. the "Arusha" template).

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.

Table 1: 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	025028	(New descriptor, scale=1, ref=-16384, bits=15)

		parameter (#3)		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 5.4.3

Proposed version 1.0 (Met Office 23/11/05)

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	Year	12	
0	04	002	Month 3 01 011	Month	4	
0	04	003	Day	Day	6	
0	04	004	Hour	Hour	5	
0	04	005	Minute 3 01 013	Minute	6	
0	04	006	Second	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	

ANNEX TO PARAGRAPH 5.5

1. TAF template

New table D and table B descriptors are listed below. Many alternatives are possible, including

- Specifying the height above ground of the forecast winds and temperature
- Not using sequence descriptors for the forecast maximum and minimum temperatures
- Not providing a single sequence descriptor for the entire forecast, but recommending a template consisting of the proposed contents of 3 07 fff
- Adding the additional time significance entries in to the code table for an existing time significance descriptor instead of creating a new one.
- Adding the forecast status entries to, or merging them with, an existing or proposed descriptor, such as the SIGMET status descriptor.

F X Y	Reference	Element/Sequence name	TAF code group(s)
		(Aerodrome forecast identification and time interval)	
3 07 aaa	0 01 063	ICAO location identifier	CCCC
	0 08 ddd	Time significance – Issue time	
	3 01 011	Year, Month, Day	YY
	3 01 012	Hour, Minute	GGgg
	0 08 eee	Status of forecast	**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 bbb	0 11 001	Wind direction	ddd
	0 11 002	Wind speed	ff
	0 11 041	Maximum wind speed (gusts)	f_mf_m
	0 20 009	General weather indicator	**CAVOK** **NSW** **NSC** **SKC**
	3 07 014	Weather	w'w'
	3 07 015	Cloud layer(s)	$N_sN_sN_sh_sh_sh_s$
		(Change indicator and forecast changes)	
3 07 ccc	0 xx ggg	Probability of following event	C_2C_2
	0 08 016	Change qualifier for an aerodrome forecast	TTTTTT
	3 01 012	Start of time change	GG GGgg
	3 01 012	End of time change	G_eG_e
	3 07 bbb	Forecast conditions during or after change	

		(Forecast of maximum temperature)	
3 07 ddd	0 08 ddd	Time significance (Time of maximum temperature)	
	0 04 004	Hour	G_FG_F
	0 12 111	Maximum temperature	T_FT_F
		(Forecast of minimum temperature)	
3 07 eee	0 08 ddd	Time significance (Time of minimum temperature)	
	0 04 004	Hour	G_FG_F
	0 12 111	Minimum temperature	T_FT_F
		(Aerodrome forecast)	
3 07 fff	3 07 aaa	Identification and time interval	
	3 07 bbb	Forecast	
	1 01 000	Delayed replication of one descriptor	
	0 31 001	Replication factor	
	3 07 ccc	Forecast change	
	3 07 ddd	Maximum temperature forecast	
	3 07 eee	Minimum temperature forecast	

Table reference	Element name	BUFR				CREX		
F X Y		Unit	Scale	Reference	Width	Unit	Scale	Width
0 08 ddd	Time significance (Aviation forecast)	Code table	0	0	6	Code table	0	2
0 08 eee	Status of forecast	Code table	0	0	4	Code table	0	1

0 08 ddd	
Time significance (Aviation forecast)	
Code figure	
0	Issue time of forecast
1	Forecast time of extreme temperature
2…62	Reserved
63	Missing
0 08 eee	
Status of forecast	
0	Normal forecast
1	Correction to a previously issued forecast (**COR**)
2	Amendment to a previously issued forecast (**AMD**)
3	Correction to a previously issued amended forecast (**COR AMD**) ** Is this allowed ?
4	Cancellation of a previously issued forecast (**CNL**)
5	No forecast available (**NIL**)
6-14	Reserved
15	Missing

2. METAR and SPECI

The existing table D entries are mostly satisfactory, but the treatment of trend forecasts is incorrect. The sequence for the full METAR/SPECI, 3 07 021, allows for only one change while up to three are permitted in the TAC and the ICAO template. In addition, the forecast clouds are not included as part of the trend forecast sequence 3 08 018 but are separate.

For many of the new table B descriptors, there are two possibilities, either using a code table as the METAR and SPECI alphanumeric codes do, or using the corresponding physical values. For example, the depth of runway deposits can be reported using a code table equivalent to code table 1079, or it can be converted to metres.

However, there is no specification of whether the report is routine (METAR) or non-routine (SPECI) in the table D sequences, nor whether or not this is a correction to a previous erroneous report. If these are included, then 3 07 011 and 3 07 020 will also need to be replaced with new sequences.

F X Y	Reference	Element/Sequence name	METAR/ SPECI Code group(s)
		(Trend type forecast, replacing 3 07 018)	
3 07 kkk	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 07 006	Height above station (10m)	
	0 11 001	Wind direction	Ddd
	0 11 012	Wind speed	Ff
	0 11 041	Maximum wind speed (gust)	f_mf_m
	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 20 001	Horizontal 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 lll	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 mmm	1 02 000	Delayed replication of two descriptors	
	0 31 001	Number of replications	
	0 01 064	Runway designator	R_RR_R
	0 xx vvv	General condition of runway	**CLRD// SNOCLO**
	0 xx www	Runway deposits	E_R
	0 xx xxx	Runway contamination	C_R

	0 xx yyy	Depth of runway deposits	$e_R e_R$
	0 xx zzz	Runway friction coefficient	$B_R B_R$
		(Full METAR/SPECI, replacing 3 07 021)	
3 07 nnn	3 07 011	Main part of METAR/SPECI data	
	3 07 012	Visibility	$VVVVD_v$
	3 07 013	Runway visual range	**R**$D_R D_R V_R V_R V_R V_R$
	3 07 014	Weather intensity and phenomena	w'w'
	3 07 015	Clouds	$N_s N_s N_s h_s h_s h_s$
	3 07 016	Recent weather phenomena	**RE**w'w'
	3 07 017	Runway shear	**WS RWY**$D_R D_R$
	3 07 lll	Sea conditions	**W**$T_s T_s$/SS'
	3 07 mmm	Runway state	$R_R R_R E_R C_R e_R e_R B_R B_R$
	1 01 000	Delayed replication of one descriptor	
	0 31 001	Replication count (0 to 3 normally)	
	3 07 kkk	Trend type forecast	

Table reference	Element name	BUFR				CREX		
F X Y		Unit	Scale	Reference	Width	Unit	Scale	Width
0 xx vvv	General condition of runway	Code table	0	0	4	Code table	0	1
0 xx www	Runway deposits	Code table	0	0	4	Code table	0	1
0 xx xxx	Runway contamination	Code table	0	0	4	Code table	0	1
0 xx xxx	Runway contamination	%	0	0	7	%	0	3
0 xx yyy	Depth of runway deposits	m	3	0	12	M	0	4
0 xx zzz	Runway friction coefficient	Code table	0	0	7	Code table	0	2
0 xx zzz	Runway friction coefficient	Numeric	2	0	7	2	0	2

0 xx vvv	
General condition of runway	
Code figure	
0	Cleared (**CLRD//)**
1	All runways closed (**SNOCLO**)
2…14	Reserved
15	Missing or not applicable
	0 xx www
	Runway contamination
Code figure	
0	Clear and dry
1	Damp
2	Wet with water patches
3	Rime and frost covered (generally less than 0.001m)
4	Dry snow

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
	0 xx xxx
	Runway contamination
Code figure	
0	Reserved
1	Less than 10% of runway covered
2	11% to 25% of runway covered
3-4	Reserved
5	25% to 50% of runway covered
6-8	Reserved
9	51% to 100% of runway covered
10-14	Reserved
15	Missing or not reported
	0 xx zzz
	Friction co-efficient
0	0.00
01	0.01
02…88	0.02…0.88
89	0.80
90	0.90
91	Braking action poor
92	Braking action medium to poor
93	Braking action medium
94	Braking action medium to good
95	Braking action good
96-98	Reserved
99	Unreliable
100-126	Reserved
127	Missing, not reported, or runway not operational.

ANNEX TO PARAGRAPH 5.6.1

\- **Code Migration Implementation Tracker**

Code type:	**Cat.:**	**Plan Exper. Exchange**	**Start Exper. Exchange**	**Plan Oper. exchange**	**Start Oper. exchange**	**Plan Migr. Complete**
SYNOP	1	Nov 2002	Nov 2002	Nov 2005	Nov 2005	Nov 2010
SYNOP MOBIL	1	Nov 2002		Nov 2005		Nov 2010
PILOT	1	Nov 2002	Nov 2002	Nov 2005	Nov 2005	Nov 2010
PILOT MOBIL	1	Nov 2002		Nov 2005		Nov 2010
TEMP	1	Nov 2002	Nov 2002	Nov 2005	Nov 2005	Nov 2010
TEMP MOBIL	1	Nov 2002		Nov 2005		Nov 2010
TEMP DROP	1	Nov 2002		Nov 2005		Nov 2010
CLIMAT	1	Nov 2002		Nov 2005		Nov 2010
CLIMAT TEMP	1	Nov 2002		Nov 2005		Nov 2010
SAREP	2	2002		2002		Nov 2006
SATEM	2	2002	2002	2002		Nov 2006
SARAD	2	2002		2002		Nov 2006
SATOB	2	2002	2002	2002		Nov 2006
METAR	3	2006		2008		2015
SPECI	3	2006		2008		2015
TAF	3	2006		2008		2015
AMDAR	3	2002	2002	2003		2015
ROFOR	3	2006		2008		2015
BUOY	4	2003	2003	2003		2012
TRACKOB	4	2003	2003	2003		2012
BATHY	4	2006	2007	2008		2012
TESAC	4	2006	2007	2008		2012
WAVEOB	4	2005	2006	2007		2012
SHIP	4	2005		2007		2012
CLIMAT SHIP	4	2005		2007		2012
PILOT SHIP TEMP	4	2005		2007		2012
SHIP	4	2005		2007		2012
CLIMAT TEMP SHIP	4	2005		2007		2012
RADOB	5	2004		2006		2008
IAC	5	2004		2006		2008
IAC FLEET	5	2004		2006		2008
GRID*(to GRIB)*	5	2004		2006		2008
MAFOR	5	2004		2006		2008
HYDRA	5	2004		2006		2008
HYFOR	5	2004		2006		2008
RADOF	5	2004		2006		2008
ICEAN	6	N/A	N/A	-	-	-
GRAF	6	N/A	N/A	-	-	-
NACLI etc.	6	N/A	N/A	-	-	-
SFAZI	6	N/A	N/A	-	-	-
SFLOC	6	N/A	N/A	-	-	-
SFAZU	6	N/A	N/A	-	-	-
ROCOB	6	N/A	N/A	-	-	-
ROCOB SHIP	6	N/A	N/A	-	-	-
RADREP	6	N/A	N/A	-	-	-
CODAR	6	N/A	N/A	-	-	-
ARFOR	6	N/A	N/A	-	-	-
WINTEM	6	N/A	N/A	-	-	-

ANNEX TO PARAGRAPH 5.6.4

West African Track and Trajectory CREX Code (WATTCC)

For squall lines observations and forecasted trajectory and evolution:

CREX++
T00020412// A007001 P00012000 U00 S001 Y20050823 H1830 D16051++
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 Lines
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
D16050	Common sequence defining Squall line 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:
	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*

ANNEX TO PARAGRAPH 6.2.2

The WMO NetCDF observations conventions could be extension of the existing CF conventions. The extension should contain:

a) Dimension

In BUFR, class 1 to 9 are coordinate classes. Class 4, 5 and 7 correspond to the NetCDF coordinates. Class 1, class 2 and class 8 are qualifying classes and their usage in the NetCDF representation has to be resolved

The CF coordinates, intervals and cells can be adopted in the Observation Convention.

b) Variables

A NetCDF variable standard name, long name and units can be created from the BUFR table B elements. BUFR reference numbers and the variable standard names should be listed to allow BUFR→NetCDF and NetCDF→ BUFR conversions. To achieve conservation of the precision during the later conversion, a new BUFR operator would be needed to request IEEE 32/64 bit packing of the floating point numbers.

c) Attributes

There are many attributes defined in the CF Conventions. One of them is flag value and flag meaning. Both are used to make variables that contain flag values self-describing. Those attributes could be used for BUFR flag and code table values. It has to be investigated if NetCDF flag value corresponds to BUFR flag value.

d) Solutions are needed for:

- Retained/replaced value
- Substituted values

For both there is a need of a mechanism to associate variable with another variable.

- Other operators

ANNEX LIST OF ACRONYMS

ACARS	AirCraft Addressing and Reporting System
ADS	Astrophysics Data System (USA)
AFWA	Air Force Weather Agency
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
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)
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)
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
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
EPA	Environmental Protection Agency
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
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
GIF	Graphic Interchange Format
GIS	Geographic Information System
GMES	Global Monitoring for the Environment and Security
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
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
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
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
NWP	Numerical Weather Prediction
NWS	National Weather Service
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
PNG	Portable Network Graphic
RA	Regional Association (WMO)
RASS	Radio Acoustic Sounding System
RDBC	Regional Data Bank Centre
RSS	Radiosonde Replacement System
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
SST	Sea Surface Temperature
TAC	Traditional Alphanumeric Codes
TCP	Tropical Cyclone Programme
TCP/IP	Transport Control Protocol/Internet Protocol
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
TOVS	TIROS Operational Vertical Sounder
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
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
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