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

TOULOUSE, 23-27 APRIL 2001

SUMMARY

The Meeting of the Expert Team Data Representation and Codes (ET/DR&C) was held in Météo-France International Conference Centre in Toulouse from 23 to 27 April 2001.

The Team reviewed the status of validation tests for the new FM 92 GRIB Edition 2 encoding/decoding. Further validation tests and experimental exchanges were recommended with a view to the use of GRIB 2 at the end of 2001/beginning of 2002, especially for the exchange of Ensemble Prediction System products.

The Team discussed and recommended additions to BUFR/CREX tables for the transmission of automatic stations (AWS) observations, for approval by CBS Ext. 02. The Meeting examined also a proposal for BUFR/CREX templates for AWS. Slovakia offered to perform validation of these templates. The templates to represent in BUFR/CREX, SYNOP, SHIP, BATHY/TESAC, BUOY, AMDAR, AIREP, TEMP+PILOT and METAR+SPECI were examined and further validations of these templates were recommended. The Meeting recommended for approval by fast track in 2001 additions to entries in Common tables for originating centres, satellites and radiosondes. The Team recommended also other additions to BUFR/CREX tables for height assignment method (from satellite), for a new significance qualifier on method of derivation of percentage confidence, for the representation of last known buoy position and of the ascending or descending orbit. A new set of additions for oceanographic data to represent in BUFR/CREX XBT, XCTD and sub-surface float information was also recommended.

At the request of CBS XII, the requirements for reporting zero and twenty-four hours precipitation in synoptic reports were discussed. New regulations for the global harmonization of precipitation reporting were proposed in FM 12 SYNOP, with a view to their approval by CBS Ext. 02.

At the request of the Chairman of the Expert Team on Migration to Table Driven Code Forms, the ET/DR&C considered the migration to table driven code forms. The members of the Team agreed that more work needed to be done to complete a full set of templates, including consideration of the existing reporting regulations, as well as regional and national practices for each code form. It was noted the original intended use of CREX has changed from only being used for new requirements. It seems there will be significant use of CREX in several Regions as a step in the transition away from traditional codes. In many locations the transition directly to BUFR will not be able to be done. In some areas, even though encoding in BUFR may be locally possible in their RTHs, transmission to these Centres and downstream may have to be done in CREX because of communication limitations. The urgent need for co-ordinated training of forecasters and observers, especially in RA I, to start late this year/early next year was emphasized.

The Meeting considered if and how XML could be used in a standard to exchange (in addition to display) meteorological information. As regards Data Representation and Codes issues, concerns were expressed about combining XML with binary data (BUFR or GRIB-encoded). Overhead associated with XML was also mentioned as a negative issue, except for data base access or visualisation. More generally, the Team felt that though it could have a potential usage, it was too early to take firm decisions about XML use for Meteorological Data Representation. In the broader context of WMO, applications well suited to XML were mainly related to metadata handling.

The Team recommended the production by a consultant of a new guide on table driven codes (BUFR and CREX) as an updated version of the current Guide to BUFR with a view to help the migration process. The Volume I.2 of the Manual on Codes on binary codes does not contain rules on reporting practices. The Team agreed that this required the creation of a new type of Manual on Reporting Practices. It also agreed to the production of a Guide on GRIB Edition 2 as an updated version of the current Guide to GRIB but in second priority. The Team recommended the merging of BUFR and CREX Tables B and D in the Manual on Codes. For the publication of supplements to the Manual, the Team stressed that a Master copy of the Manual kept on the WMO Web server would greatly reduce the delays, and asked the Secretariat to study this possibility, as had been done for Pub. 9, Volume A.

REPORT OF MEETING OF EXPERT TEAM ON DATA REPRESENTATION AND CODES

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REPORT OF THE MEETING OF EXPERT TEAM ON DATA REPRESENTATION AND CODES
(Toulouse, 23-27 April 2001)

1. ORGANIZATION OF THE MEETING

1.1 OPENING OF THE MEETING

1.1.1 The Meeting of the Expert Team on Data Representation and Codes (ET/DR&C) took place at Météo-France Conference Centre in Toulouse from 23 to 27 April 2001 (the participants' list can be found in the Annex to this paragraph). The Meeting was opened on Monday 23 April at 9 a.m. by Mr Jean Clochard, Chief of Operation Division, Information System Management and Chairman of the Team. He welcomed the participants and stressed that one of the main task of the team was to ensure that GRIB Edition 2 was operational to transmit fields which cannot be transmitted in GRIB Edition 1. The Team will also have to deal with BUFR updates, in particular finalize templates for the exchange of data in BUFR, and to study possibilities of using XML in meteorology. The Chairman wished a good stay in Toulouse to all the participants. The WMO representative thanked Meteo-France for its kind hospitality and excellent facilities. He stressed the importance of this team because WMO codes are fundamental to meteorology. They make possible the real time exchange of data, the raw material for all meteorological processing and applications. The experts on data representation and codes had several challenging tasks on the agenda for this week. The terms of reference of the team include:

a) maintain all WMO data representation forms and further develop table driven codes by defining descriptors, common sequences and data templates, so they meet the requirements of all Members most efficiently;
b) invite and assist members to participate in the experimental exchange of data encoded in modified or new formats, in BUFR, CREX, and GRIB 2 on a bilateral basis;
c) define standards for meteorological information using XML as appropriate;
d) produce a guide on table driven codes as an updated version of the current guide to BUFR and GRIB.

Of course, the ongoing requirements for maintaining the old character codes should not be forgotten. However, one should realize that even minor changes to an existing code form could mean major software changes and thus substantial costs for most member states. A freeze of the character codes has been recommended often by CBS but has not been feasible. A new requirement for global harmonization of precipitation reporting will have to be considered. The outcome of the work of this week will be a set of recommendations on data representation and codes, which will be submitted for fast track approval in 2001 or will be considered in 2002 by the ICT of the OPAG on ISS and by the extraordinary CBS in Fall 2002.

1.1.2 Mr Jean Clochard, as Chairman of the ET, led the Team with diplomacy and efficiency.

1.2 APPROVAL OF THE AGENDA

The Team agreed to the content of the agenda as proposed, with the addition of item 4.3 on issues related to migration to Table Driven Codes (see Table of Contents in front).

2. GRIB 2 CODE FORM

2.1 STATUS AND COORDINATION OF FINAL VALIDATION TESTS FOR GRIB 2 ENCODING/DECODING

2.1.1 CBS regulations require validation of all proposals for new data representation forms with two independent encoders and two independent decoders. Since the meeting of the Implementation/Coordination Team on Data Representation and Codes (ICT/DR&C) in Geneva from 10 to 14 April 2000, a lot of validation efforts for GRIB Edition 2 have taken place. Based on the results of the validation tests, the CBS in its XII session in November 2000, had confidence that the overall

structure of GRIB Edition 2 was sound and the Commission agreed that the Edition 2 of FM 92 be adopted as an operational WMO code as from 7 November 2001. However, the Team found that there were still a certain number of templates, which had not been validated. The Team examined the list of templates with the corresponding validation tests as listed in Annex to this paragraph. The Team updated these tables and checked the possibilities and commitments of the various Members to perform more tests.

2.1.2 A number of Centres outlined their plans for developing their decoder/encoders and to participate in validation exercises. UKMO hopes to have a decoder ready by June 2001, and could start to decode data in July. US/NCEP will coordinate activities with US/TDL, the US Navy and the US Air Force. ECMWF will make their GRIB 2 data available for those who can try to decode Grid Definition Templates (GDT): 3.1 to 3.3 and 3.41 to 3.53, and Product Definition Templates (PDT) 4.2 to 4.7. ECMWF will also try to decode US/NCEP data. DWD should be approached for encoding and decoding of GDT 3.100. US/NCEP will consider decoding of GDT 3.110 and 3.120, PDT 4.20 and Data Representation Templates (DRT) 5.50 and 5.51, and associated Data Templates (DT) 7.50 and 7.51, from ECMWF. Maximum efforts will be made by these Centres to complete as much validation as possible, so that the templates can be listed as operational in the initial version of GRIB 2 (see the Annex to this paragraph).

2.1.3 The Team did find that DRT 5.1 (Matrix values at grid point – simple packing) and DT 7.1 were not validated enough and should remain experimental for the time being with a note explaining this situation in the Manual (see in the Annex to this paragraph the proposed note). These additional notes are recommended for fast track approval.

2.1.4 As a complement, it was suggested that to help validation and with a view to assist migration, a short questionnaire should be circulated by e-mail to producers of GRIB 2 fields, namely representatives of Australia, Canada, Deutscher Wetter Dienst, JMA, Météo France, USA, UKMO and ECMWF, as well as to other potential producers. Each Centre should give the following information about their own GRIB 2 package(s):

- current status of encoding/decoding
- willingness to participate to final validation tests
- templates intended for use (in the medium term), and estimated target dates associated
- information on programming languages used for package(s) and associated platform(s)/operating system(s)
- information on programming languages supported by application interfaces (APIs)
- willingness to participate to a possible development of a standard API for GRIB 2 software.

The questionnaire is found in the Annex to this paragraph.

2.2 DEFINITION OF ADDITIONAL TEMPLATES FOR THE TRANSMISSION IN GRIB 2 FOR CROSS-SECTIONS AND HOVMÖLLER TYPE DIAGRAMS:

2.2.1 The last ICT on DR&C and CBS had recommended that further work be undertaken urgently to define additional templates for the transmission in GRIB 2 of Cross-sections and Hovmöller type diagrams. The Team found that no work had been done on this issue. An ad-hoc sub-group was convened during the meeting and drafts of Grid Definition Templates and Product Definition Templates were defined. In addition, work was started for the representation of time-sections diagrams. The drafts are given in the Annex to this paragraph. The Team recommended that some of its members approach potential users to review the drafts before validation.

2.3 ANY ADDITIONS OR MODIFICATIONS TO GRIB 2 FOR FAST TRACK BEFORE IMPLEMENTATION ON 7 NOVEMBER 2001

2.3.1 UK reported a notorious error in Grid Definition Template 3.120, which the Team, after

examination, considered it to be an editorial error. The new version of the template can be found in the Annex to this paragraph.

2.3.2 The Team noted the request for other models of earth representation and then recommended new entries for Code table 3.2 "Shape of the earth", as listed in the Annex to this paragraph, for fast-track approval. The ICAO will be contacted to refine the reference to WGS84.

2.4 IMPLEMENTATION OF EXPERIMENTAL AND THEN OPERATIONAL EXCHANGES OF FIELDS IN GRIB 2

2.4.1 If one tries to refer to the previous GRIB edition change, namely the move to GRIB edition 1 in 1991:

- at that time, the new edition replaced the previous one at standard level
- since 1991, the number of GRIB products has considerably grown, together with the resolution of products and the number of users; in the same time few GRID products were added, and the users of GRID became less and less.

2.4.2 Obviously, the complete replacement of GTS GRIB products coded in GRIB1 by products coded in GRIB 2 would lead to very important perturbations. Furthermore, the ICAO (WAFS) GRIB products will be kept in GRIB1 for a long time, at least up to 2008. This will limit evolution in two ways: at terminal systems level (visualization), and also because the associated producers (USA/NWS and UKMO) deliver extended sets of products with respect to the ICAO rules.

2.4.3 In practice, we should keep in mind that GRIB 2 was mainly designed to handle cases that could not be coded in GRIB1, or not properly. The first experimental exchanges should focus on the following cases:

- EPS products
- products from RSMCs specialised in pollutant dispersion (transport) models
- EUMETSAT image products
- products where the two fixed coordinates do not correspond to horizontal geometry.

The last mentioned application is more uncertain (see paragraph 2.2.1).

2.4.4 Following a WMO request, the ECMWF Council had decided to deliver EPS-derived probabilistic fields on GTS. The representative of ECMWF indicated to the team that the Centre will start to transmit EPS products on the GTS by the end of 2001/beginning of 2002. Such products will be encoded in GRIB 2.

2.4.5 For transport model output, Météo France is willing to distribute its RSMC products (concentration and deposit fields) in GRIB 2 form. However, the Chairman (from Meteo-France) stated that there were uncertainties in the calendar, since development work should not interfere with the operational production of the transport model, for which security and time response were a major issue.

2.4.6 The representative of EUMETSAT indicated that soon, before the end of 2001, on request, archived images could be delivered in GRIB 2 format. EUMETSAT will also provide on request GRIB 2 software to transform the rapid scan data in GRIB 2 format. Transmission of these data will not be done through GTS, given their very high volume.

2.4.7 Implications at GTS and GDPS level

2.4.7.1 The difficulty of transmitting data in GRIB format on the GTS, because of the bulletin size, was discussed. The difficulty will be exacerbated with the introduction of GRIB Edition 2 products.

2.4.7.2 If EPS products mentioned above were to be distributed “as usual” over GTS, it should be mentioned that the GRIB 2 form enables blocking of products within a single envelope. This gives the possibility to associate the two components of a wind vector, but also the opportunity to have results delivered in a way more consistent with their production. For instance, blocking results as regards levels, parameters, and possibly zones (up to one file per range of model run). For EPS results, individual members may also be blocked together to help building derived products with full flexibility.

2.4.7.3 This naturally tends to a delivery in file form rather than (lots of) bulletins. This reinforces the need of files delivery through GTS, as enforced by several CBS sessions, and especially CBS-XII. The number of entries to manage at switching directory level would be drastically reduced. On the longer term, a greater move to GRIB 2 will certainly come with the implementation of enhanced resolution products. This will mean extra bandwidth, however with large enough grids the complex packing should half the need (this is also a reason not to split grids). Thus, at some point the interface with GTS will be able to handle files; this would be to some extent a simplification, except if splitting into zones remains a necessity for the distribution.

2.4.7.4 At the GDPS level, there is, in priority, the need to have encoding and/or decoding software packages.

2.4.8 CBS has established an Expert Team on Ensemble Prediction System (ET/EPS). The terms of reference of this team include: (c) Develop and test procedures for exchange of EPS GRIB data, including the needs of large centres to exchange their ensemble; and (d) Provide requirements for the dissemination of the products to the OPAG on ISS to help determine appropriate means of dissemination, where appropriate, work with the OPAG on ISS to assess telecommunication implications. The ET/EPS had addressed a note to the ET/DR&C. The ET/DR&C discussed the matter of representation of EPS data and elaborated an answer to the ET/EPS, providing information on the envisaged ways of transmitting EPS data using GRIB 2 or BUFR.

2.4.8.1 The Team considered the various products generated by the Ensemble Prediction Systems. It found that all basic generated fields, including probability fields and sets of ensemble members (like “stamps” charts), defined on horizontal grids, could be transmitted in GRIB 2. However the more elaborated products, like “spaghettis” plots and “plume” meteograms, which have more a vizualisation function, were more suited for transmission in BUFR than in GRIB 2. Meteograms were transmitted in BUFR. The ECMWF representative indicated ECMWF was already transmitting meteograms in BUFR. This method could probably be used also for ensemble meteograms. The Team recommended that templates for the transmission of meteograms be produced to be shown as examples. “Spaghettis” diagrams will have to be transmitted as a sub-set of the ensemble grid point fields, perhaps on pre-defined sub-regions, and the actual contouring of the iso-lines should be done by the end-user processor, before display. Indeed, products can always be transmitted in graphical format through the Internet.

2.4.8.2 The ET/DR&C would like to have a more precise expression of the requirements for EPS products transmission, including also the volume (with area and resolution) of data involved, to better met these requirements after the next meeting of the OPAG on DPFS/ET on EPS in October 2001.

3. BUFR AND CREX

3.1 ADDITIONS FOR TRANSMISSION OF AUTOMATIC STATIONS OBSERVATIONS

3.1.1 The Team agreed to expand Flag Table 0 20 021 to 30 bits and to include additional entries in it. Since this has not been used yet (operational only on 7 November 2001), it recommended these additions for fast track approval (see the Annex to this paragraph).

3.1.2 The first session of the Expert Team on Requirements and Representation of Data from Automatic Weather Stations (ET/AWS) examined a proposal for a BUFR/CREX template for AWS data that had been developed by the ET/AWS in co-operation with the ICT on Data Representation and Codes. A revised version was presented at the meeting following the work done by the experts: E. Èervená, M. Dragosavac, M. Ondráš and I. Zahumenský.

3.1.3 The Team agreed that a set of new descriptors was required. The Team recommended that these new descriptors and new template be used for experimental exchange to complete the necessary validation tests. Slovakia has signified its willingness to validate the templates and the new descriptors.

3.1.4 The Team also discussed the metadata needed for the vertical co-ordinates of a station. It agreed that new descriptors had to be defined to accurately express all the required information. The AWS experts have specified their requirements for metadata referring to position of sensors:

- information on height of a sensor above the ground at the point where the sensor is located (the observing area is not actually a horizontal plane if the accuracy to 0.01 m is required). This datum will be used to report how representative the measured values (of temperature, humidity, wind, etc.) are.
- information on height of sensor above mean sea level (with accuracy to 0.1 m). This datum will be used mainly for pressure sensors, but it may be available to express altitude of any sensor, if required.

The Team agreed to add three new descriptors defining the height above mean sea level of the station ground, the height of sensor above mean sea level and the height of sensor above local ground. Notes will be added to all the descriptors explaining their use. Notes will also be added to clarify the use of the existing descriptors 0 07001 and 0 07 006, which if used in the archives, should not be employed anymore.

3.1.5 The last version of template for AWS and the required new descriptors are listed in the Annex to this paragraph. The validation process may lead to further modification or additions prior to final approval by the CBS. Close collaboration of ET/DR&C and ET/AWS with the WMO technical commissions concerned and other relevant international bodies, in particular with EUMETNET, might be necessary in finalizing the above proposals, especially concerning the new descriptors for the AWS. They will be re-examined after validation by the Team in 2002.

3.2 APPROVAL OF TEMPLATES IN BUFR/CREX FOR SYNOP, SHIP, BATHY/TESAC, BUOY, AMDAR, AIREP, TEMP+PILOT AND METAR+SPECI

3.2.1 The Commission for Basic Systems, with a view to further promoting the use and understanding of the table driven codes requested the ET on DR&C to define data templates (i.e. layout of the observation report) in BUFR and CREX for all observations (not all in CREX, e.g. satellite data) for inclusion in the Manual on Codes as an Attachment.

3.2.2. A document submitted by US/NCEP described the current status of BUFR/CREX templates development for the traditional SYNOP, SHIP, BATHY/TESAC, BUOY, AMDAR, AIREP, TEMP+PILOT and METAR+SPECI data types. An ad-hoc subgroup of the meeting reviewed the proposed templates and recommended several further changes. Valuable input was also obtained from Mr. Etienne Charpentier of the DBCP/SOOP panel regarding buoys, XBT platforms, and subsurface floats. Since there was more of a pressing need to be able to transmit these data types in BUFR, the subgroup reviewed several proposed new descriptors for these templates and recommended that they be approved for fast-track implementation. All such new descriptors, as well as updated versions of all of the templates and accompanying explanatory notes, can be found in the Annex to this paragraph.

3.2.3 It is to be noted that all these templates are still considered as “draft” versions and are not yet fully finalized nor validated. Specifically, several action items, as detailed in the explanatory notes, were still to be completed, and all of the templates were to be reviewed further in light of the reporting practices listed for each respective code form within WMO Manual 306, Volume I.1 (so far, this had been done only for SYNOP, SHIP, AMDAR, and radiosonde pressure/height). Finally, all templates should be validated via exchange between Centers of observations encoded using these templates. At the appropriate time, the Chairman of the ET/DR&C Team will coordinate the validation of these templates. The ET on DR&C will be able to define sequences for the Table D, for approval by CBS (or its president through fast track). For the data transmission, the producers were really the deciders who must define what they want to transmit according to their needs, which might be different from one country to another. For that purpose, the flexibility and expandability of BUFR should be fully used, and the ET on DR&C could define the main core common sequences which correspond to the traditional codes and other "core" sequences, which might be expanded at the discretion of the producers, in particular for the addition of metadata for the automated observing systems.

3.3 ADDITIONS TO COMMON TABLES, E.G. RADIOSONDES

The Team recommended for fast-track approval the additions to Common Tables as listed in the Annex to this paragraph.

3.4 OTHER ADDITIONS TO BUFR/CREX

3.4.1 Several requests for addition to BUFR/CREX Tables were proposed to the Team, which recommended them for fast track approval. They are listed in the Annex to this paragraph.

3.4.2 Editorial correction

BUFR descriptor 0 02 151, Radiometer identifier, was defined in the BUFR tables on the WMO server and in the printed copies of the Manual on Codes to have data width 4 bits. The issue had been resolved at a previous meeting by the ICT/DR&C. Both NESDIS and the UK MetOffice used a data width of 11, and data were currently being distributed with this data width and archived by the ECMWF with this data width. To the best of the knowledge of the Team, no data were currently being distributed by any originator using a data width of 4. The Team agreed to the editorial correction as listed in the Annex to this paragraph.

3.4.3 Additions for oceanographic data

A set of new descriptors was requested by Service ARGOS for representing XBT/XCTD data and sub-surface profiles from sub-surface floats. The Team recommended them for fast track approval. They are listed in the Annex to this paragraph.

3.4.4 Proposition for a new BUFR Table C operator

Mr Jeff Ator proposed a new operator within BUFR Table C, which would simplify the procedure of changing descriptor precision by combining the functionality of current Table C operators 2-01-Y, 2-02-Y, and 2-03-Y, changing in one step scale, reference value and data width. The Team found the proposal elegant. However, it would be complicated to implement especially for the encoder and decoder software that will have to be developed. The Team recommended that more work be done on this subject, with the possibility of making available an algorithm to perform the conversion. To that effect, further information exchange, as well as testing and validation will be performed by US/NCEP, ECMWF and UKMO in the coming year, so that a refined and validated proposal could be presented at the next ET/DR&C.

3.4.5 Representation of Probabilities and other Forecast Data within BUFR/CREX

Ideas were presented to the Team by Jeff Ator for representing probability, conditional probability, categorical ranges, and other categorical forecast data within BUFR and CREX (see the Annex to this paragraph). The Team appreciated this effort and could see the use of these new entries to represent in particular data derived from ensemble predictions. The Team requested its members to urgently perform more work for the definition and the validation of these entries, with a view for its approval via fast track in 2002.

4. MODIFICATIONS TO TRADITIONAL ALPHANUMERIC CODES

4.1 THE REQUIREMENTS FOR REPORTING PRECIPITATION AND ITS GLOBAL HARMONIZATION

The requirements for global harmonization of reporting precipitation had been expressed by the Expert Team on Surface Data Quality Monitoring and by CBS XII. To address shortcomings identified in accounting for correct accumulation of precipitation amounts reported over a 24 hour period, the ET/DR&C considered that all WMO Regional Associations be approached to put their regional (and national) procedures in line with the requirements expressed by the Commission. CBS XII had invited the ET/DR&C to revise the procedures with a view to mandatory reporting of 24 hour precipitation and reporting zero measured precipitation as zero in the code as recommended by the Expert Team on Surface Data Quality Monitoring. On this ground, the Team recommended the modifications to FM 12 regulations as listed in the Annex to this paragraph.

4.2 CONSIDERATIONS FOR MIGRATION TO TABLE DRIVEN CODE FORMS

4.2.1 The Chairman of the Expert Team on Migration to Table Driven Code Forms (ET/MTDCF), Mr Fred Branski thanked the Chairman and members of the ET/DRC and the Secretariat for the opportunity to discuss migration issues with them. He pointed out the ET/MTDCF grew out of the work done over the last several years by the Implementation Coordination Team on Data Representation and Codes. As such, some ET/DRC members are aware of the many issues and problems. He provided the ET/MTDCF terms of reference established by CBS-XII.

4.2.2 With a view to the work being undertaken by the ET/MTDCF and upon its relationship to the work being done by the ET/DRC, the following list of considerations were provided and the members asked to discuss these and provide their views. They were also encouraged to raise other issues pertinent to migration.

a. Standard BUFR and CREX templates greatly facilitate use and exchange of data in these code forms. Additional templates will be needed. How should the two teams work to develop these templates?

b. Some WMO members have national practices that differ from global procedures and regional practices. How can the two teams best work together to eliminate or incorporate these differences into the migration plan?

c. What should be the extent of universality of table driven codes? Should their use extend beyond data exchange and archive? Is there a role for traditional code forms at the display level or for other uses? How should this issue be treated?

d. What should be the extent of commonality between BUFR and CREX?

e. Is there a role for CREX beyond an interim or transitional use? Once BUFR is in use by all WMO members and associates, should CREX be deprecated? CREX is currently being used for exchange of ozone data, radiological data, hydrological data, tide gauge data, soil

temperature data, tropical cyclone data and for aerodrome warning messages; will all of these uses have to completely migrate to BUFR? Does CREX' human interface ability warrants it being kept as a permanent code form.

f. What impact will the migration plan have on current implementation procedures? Are current procedures sufficient? Are changes needed? Is there a need for special or temporary transitional procedures? Is there a need for special or temporary implementation authority?

g. What impacts will migration have on the Manual on Codes? What about other documents such as the ICAO Annexes?

4.2.3 The members of the Team agreed there needs to be more work done to complete a full set of templates with important consideration of the existing regulations, as well as regional and national practices for each code form. It was noted that although there is some usage of BUFR and CREX, not a single traditional code form has been migrated yet and establishment of deadlines should be considered. It was also agreed the ET/MTDCF would provide new or updated requirements as needed to ET/DRC.

4.2.4 It was noted the original intended use of CREX has changed from only being used for new requirements. It seems there will be significant use of CREX in several Regions as a step in the transition away from traditional codes. In many locations the transition directly to BUFR will not be able to be done. In some areas, possibly RA I and II, even though encoding in BUFR may be locally possible in their RTHs, transmission to these Centres and downstream may have to be done in CREX because of communication limitations. The urgent need for co-ordinated training of forecasters and observers, especially in RA I, to start late this year/early next year was emphasised. There was also a need to examine what can be done at the various sub-MTN levels of the GTS.

4.2.5 The importance of a comprehensive guide to table driven codes was agreed. It needs to include not only a clear explanation of the code forms but also guidance on common practice, information on how parameters, descriptors or templates are added or updated, implementation and validation procedures and coverage of transition issues. This document is needed early in the migration process. It was agreed the two teams would work together to define more explicit requirements for the content of the document to facilitate its completion. Since there was no CREX guide at all, this should be given high priority.

4.2.6 Several of the other papers and issues discussed at this meeting pointed to additional mutual concerns of the two ETs. It was agreed the two teams would need to work together closely. The two Chairmen agreed they will strive to keep each of the other teams aware of each other's progress.

5. DEFINITION OF STANDARDS FOR METEOROLOGICAL INFORMATION USING XML

The terms of reference for ET/DR&C, as updated at CBS-XII, include the potential interest of XML. A document submitted by the Chairman summarized the history of XML, and gave some ideas on what might be done with it.

5.1 XML acronym stands for "eXtensible Markup Language". Such languages were developed in Internet context to exchange data, markups (or tags) being text-oriented entities delimited within characters '<' and '>'. Markup Languages put structures and rules on top of that. Examples are SGML (ISO standard) and HTML, widely used on the web.

5.2 XML is an intermediate between SGML (heavy to manage) and HTML (which ties the presentation issues with data). It is a W3C standard (the international structure that manages Internet). An XML document contains only data; a separate document (style sheet) is needed for its presentation. And except for simple cases, a third document will be needed (data description sheet). A standard API exists,

free and downloadable (as W3C technology) for a variety of implementations.

5.3 Key advantages come from the separation between data and presentation, and extensibility (things may be added without interference with pre-existing use), in the spirit of the “object-oriented” approach. XML is a platform to build its own data base, with its own programs/procedures for access/manipulation (based on basic tools). Main applications of XML are to provide value-added services in “open” (and/or heterogeneous) environments.

5.4 The advantages of XML over HTML are more efficient searches within web sites, whilst different style sheets enable to customise access per user category, and terminal adaptation. More and more commercial software (such as Internet browsers, DBMSs) provide an interface to XML. Use of XML in general is expanding, mostly within firms in their Intranets and associated tools.

5.5 The US Navy has developed its own “Weather Observation Markup Format (OMF)" for observation reports, to “annotate” the traditional alphanumerical codes with additional metadata (station names, complete time stamps) and derived data (explicit cloud ceiling for METAR). Several centres are interested in, or have already started using XML (NWS, Météo France, AFWA, Australia, EUMETSAT). Initiatives are also coming from the commercial sector.

5.6 As regards Data Representation and Codes issues, concerns were expressed about combining XML with binary data (BUFR or GRIB-encoded). Overhead associated with XML was also mentioned as a negative issue, except for using data bases or visualisation. More generally, the Team felt that though it could have a potential usage, it was too early to take firm decisions about XML use for Meteorological Data Representation.

5.7 In the broader context of WMO, applications well-suited to XML were mainly related to metadata handling. This might for instance be used in GTS context for the transfer of metadata information files that could be transmitted along with data files (without headers in the content).

5.8 In the same spirit, XML might be a used for data description in “pull” requests to servers as imagined in the “future WMO information systems” presented at CBS XII.

5.9 Web-based references for more explanation on XML are given in the Annex to this paragraph.

6. PRODUCTION OF A NEW GUIDE TO DATA REPRESENTATION

6.1 GUIDE ON TABLE DRIVEN CODES (BUFR, CREX) AS AN UPDATED VERSION OF THE CURRENT GUIDE TO BUFR

A broad-scale document on the topic was produced for CBS-XII, but mainly for decision-makers. The Team expressed the need for such a document, with a special concern as regards the migration plan. The Team found that, for manufacturers of automated observing platforms, the current Guide to BUFR was not explanatory enough. To assist with these issues, examples using the readability of CREX would help understanding. The expert from UKMO mentioned that his service had some materials that could be useful, and that he would make them available to the Team.

6.1.1The Team drafted a general outline that could be used:

- general introduction
- how the codes works and how they may be used
- programmers-oriented layer

6.1.2 The Chairman of the ET on Migration supported the general idea, pointing out that the second

point mentioned above would greatly depend on targeted readers. He estimated also that, at least for Migration purposes, web pages describing Table-driven Codes would be necessary.

6.1.3 The expert from DBCP&SOOP expressed the need for practical detailed explanations; for example:

- "how cumulative values", or "how data producers or originating centres" can be encoded?
- "what are the update procedures?" (validation tests)
- "what packages are available?" (specify ways to get them)
- give references to tables on electronic form.

6.1.4 Taking into account the volume of necessary work, the Team recommended that a consultant be hired to write the required new Guide.

6.2 GUIDE ON GRIB EDITION 2 AS AN UPDATED VERSION OF THE CURRENT GUIDE TO GRIB

6.2.1 The current Guide on GRIB has been well appreciated, but should be renamed as "Guide to GRIB edition 1", and kept as such. A Guide for GRIB edition 2 was also recognised as necessary, though at lower priority than the Guide for Table Driven Codes. The team felt that a more pressing need for this Guide would arise when more GRIB 2 products will be available which is expected for next year.

6.2.2 For the guide to GRIB Edition 2, one suggestion was made to keep the introduction from the current GRIB1, modifying the details relevant to GRIB 2, and add guidance for the use of GRIB 2. Another suggestion was to use a different approach explaining the general philosophy and logic of the code in the introduction to the Guide.

7. MANUAL ON CODES

7.1 IMPLEMENTATION OF THE PROCEDURES APPROVED BY CBS FOR MODIFICATIONS TO THE MANUAL ON CODES

The Team took note of the validation procedures recommended by CBS XII for the modifications to the Manual on Codes and would ensure that they will be followed. The Team expressed concern on the practical delay of six months between the approbation of a modification and its possible implementation. The Team understood that the delay of 3 months, in addition to the 3 months required to warn the WMO Members, was due to the publication work for the production of the hard-copy of the Manual. The Team stressed that a Master copy of the Manual kept on the WMO Web server would greatly reduce the delays, and asked the Secretariat to study this possibility, as had been done for Pub. 9, Volume A.

7.2 NEW PRESENTATION OF BUFR AND CREX TABLES B AND D

7.2.1 Since entries of Tables B in BUFR and CREX are listed in both Codes, it was proposed to merge the two tables, which will simplify greatly the maintenance of the Manual. The team agreed to the merging of the BUFR and CREX Tables B, with a view for its presentation in the next supplement of the Manual coming in the third quarter of 2001. The difference between the descriptor format 0 nn mmm and Bnnmmm should be clearly indicated.

7.2.2 The Implementation and Coordination Team on Data Representation and Codes (ICT/DR&C) decided at its meeting (Geneva, 10-14 April 2000) to keep the BUFR and CREX tables coupled, and agreed that it was also effective way to promote the migration to Table Driven Codes. In this regard, however, it seemed that some extensive examination was necessary to make the tables identical with each other from a practical utilization point of view. In this context, Japan proposed some modifications to the BUFR and CREX Table D.

7.2.2.1 In the current version of Manual on Codes Volume I.2, the sequence descriptors of CREX were specified partially, and the remainder had to be generated from BUFR Table D when necessary. On the

other hand, Category 05 - Meteorological or hydrological sequences hydrological observations were only in CREX Table D. Therefore originators or users of CREX messages had to convert sequence descriptors of BUFR into those of CREX to encode/decode CREX messages, and users of BUFR messages had to convert to obtain BUFR sequence descriptors, also, when necessary.

7.2.2.2. On the whole, conversions between sequence descriptors of BUFR and CREX were quite simple, i.e., only replacement of digit and letters for part "F" in each descriptor was required. However, since functions of operator descriptors of BUFR were slightly different from those of CREX, and furthermore, BUFR had more operator descriptors than CREX, conversion from some sequence descriptors of BUFR that included operator descriptor(s) into those of CREX was difficult and not straightforward. Conversion of replication descriptor, especially with nested replication, was complicated, and prone to erroneous encoding/decoding for people who were not familiar with BUFR and CREX.

7.2.2.3 In order to eliminate these difficulties, it is necessary to define the sequence descriptors in BUFR and CREX Table D explicitly. Japan even proposed to present both tables in parallel in the same page. Some additions of sequence descriptors to the BUFR and CREX Table D were also proposed by Japan. The Team agreed to these proposals, as listed in the Annex to this paragraph and wished them to be implemented for the next supplement of the Manual.

7.3 PRODUCTION OF A MANUAL ON REPORTING PRACTICES (EXTRACTION OF REPORTING PRACTICES FROM VOLUME I.1)

It is a fact that the Manual on Codes, Volume I.1, contained more regulations related to reporting practices than formatting rules. The Volume I.2, on the other hand defined formatting systems, and practically no reporting regulations. The migration to BUFR/CREX would push producers and users of BUFR/CREX codes to consider Volume I. 2, rather than Volume I.1. Besides, the link between the transmission format BUFR/CREX, data elements, descriptors and Common Sequences, with the observations (reports performed within the frame of a well defined agreed internationally meteorological operation) would have to be rebuilt.

7.3.1. The Team agreed that a new concept of "meteorological report" had to be introduced, and the Volume I.1 which defined code forms would have to be used as a base to write a new Manual on Reporting Practices, which would define Synoptic Reports, Buoy reports, Upper-level report, etc. Once, this would be accomplished and the WMO Member States had all migrated to BUFR/CREX, then Volume I.1 could be put into the archives.

7.3.2 The Annex to this paragraph lists an attempt to convert the first pages of FM 12 SYNOP. It shows the difficulty of this task. To create the link between BUFR/CREX and the existing regulations would be cumbersome. At the same time, proper common sequences would have to be defined. Another idea could be the inclusion of BUFR/CREX templates as examples in the new Manual.

7.3.3. The Team agreed that this work would require the service of a consultant. The consultant could contact WMO Members who had done some work on this subject (i.e. Canada, UK). The Team recommended this activity to be performed under the responsibility of the WMO Secretariat. The Manual on Reporting Practices, once written, would have to be evaluated and certified by the ET on DR&C.

8. ACTIONS PLAN

The Team recommended that an Expert Team meet in April 2002, prior to the Meeting of the ICT of OPAG on ISS. The Team took note with appreciation of the invitation of the representative of the Czech Republic to host the Meeting of the ET/DR&C in Prague in 2002. The Team will have, among other tasks, to review the status of actions to be performed as defined below and the need for fast-track additions for implementation in November 2002, and to finalize the recommendations for CBS Ext.02.

The Team agreed that the following actions were to be undertaken:

- Maximum efforts will be made to complete as much validation as possible.
- Centres completing development of their GRIB 2 decoder/encoder software to participate in validation exercises:
    - UKMO to decode, starting in July.
    - US/NCEP to coordinate activities with US/TDL, the US Navy and the US Air Force for validation.
    - ECMWF to make GRIB 2 data available.
    - ECMWF to decode US/NCEP data.
    - DWD to be approached for encoding and decoding of GDT 3.100.
    - US/NCEP will consider decoding of GDT 3.110 and 3.120, PDT 4.20 and Data Representation Templates (DRT) 5.50 and 5.51, and associated Data Templates (DT) 7.50 and 7.51, from ECMWF.
    - Validation of templates 5.1 and 7.1.
    - Review and validation of templates for cross-sections, time-sections and Hövmoller type diagrams.
- Distribution of a questionnaire on each Member GRIB 2 package.
- Experimental exchange of EPS products (ECMWF), products from RSMCs specialised in pollutant dispersion (transport) models (Météo-France) and EUMETSAT image products.
- Templates for the transmission of meteograms in BUFR to be produced (ECMWF).
- Slovakia to validate template for AWS data.
- To complete and validate templates for SYNOP, SHIP, BATHY/TESAC, BUOY, AMDAR, AIREP, TEMP+PILOT and METAR+SPECI data types.
- Further information exchange, as well as testing and validation to be performed by US/NCEP, ECMWF and UKMO in the coming year for a refined and validated proposal of new Table C operator.
- To urgently perform more work for the definition and the validation of the entries for the representation of probabilities and other forecast data within BUFR/CREX (US/NCEP, ECMWF and UKMO).
- Urgent need for co-ordinated training to BUFR/CREX/GRIB 2 of forecasters and observers, especially in RA I, to start late this year/early next year (Secretariat).
- Need to examine what can be done at the various sub-MTN levels of the GTS (ET/MTDCF).
- For Migration purposes, more web pages describing Table-driven Codes would be necessary.
- A consultant to be hired to write the required new Guide to Table Driven Codes (BUFR/CREX) (Secretariat) (first-priority).
- A consultant to be hired to write a new Manual on Reporting Practices (Secretariat) (second-priority).
- A consultant to be hired to write the new Guide to GRIB edition 2 (Secretariat) (third-priority).
- Master copy of the Manual on Codes to be kept on the WMO server (Secretariat).
- Merging of BUFR and CREX Tables B and D (Secretariat).

9. CLOSURE OF THE MEETING

The Meeting was closed by the Chairman of the ET on DR&C at 17.00 on Friday 27 April 2001.

ANNEX TO PARAGRAPH 1.1.1

ET/DR&C, Toulouse, 23-27 April 2001

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ANNEX TO PARAGRAPH 2.1.1

VALIDATION OF GRIB EDITION 2

Table 1: Validation of GRIB Edition 2 Grid Definition Templates

GDT 3.0			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN,**
			=====>US/TDL and
			=====>ECMWF
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP and**
			=====>FRANCE
data encoded by	**=====>JAPAN**	**was decoded by**	**=====>US/NCEP and**
			=====>Japan
data encoded by	**=====>ECMWF**	**was decoded by**	
GDT 3.1			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN and**
			=====>ECMWF
data encoded by	**=====>ECMWF**	**was decoded by**	
GDT 3.2			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN and**
			=====>ECMWF
data encoded by	**=====>ECMWF**	**was decoded by**	
GDT 3.3			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN and**
			=====>ECMWF
data encoded by	**=====>ECMWF**	**was decoded by**	
GDT 3.10			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN and**
			=====>US/TDL
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP**
GDT 3.20			
data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN,**
			=====>ECMWF and
			=====>US/TDL
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP**
data encoded by	**=====>ECMWF**	**was decoded by**	

note: JAPAN developed their GRIB Edition 2 encoding and decoding software independently. Thus it is a valid test for them to decode the data they themselves encoded.

GDT 3.30

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN and =====>US/TDL**
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP and =====>EUMETSAT**

GDT 3.40

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	**=====>US/NCEP**

GDT 3.41

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.42

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.43

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.50

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.51

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.52

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.53

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

GDT 3.90

data encoded by	**=====>US/TDL**	**was decoded by**	**=====>EUMETSAT**
data encoded by	**=====>EUMETSAT**	**was decoded by**	**=====>US/TDL**

GDT 3.100

data encoded by	**=====>US/NCEP**	**was decoded by**	

GDT 3.110

data encoded by	**=====>US/TDL**	**was decoded by**	

GDT 3.120

data encoded by	**=====>US/TDL**	**was decoded by**	

Table 2: Validation of GRIB Edition 2 Product Definition Templates

PDT 4.0

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN, =====>US/TDL and =====>ECMWF**
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP and =====>FRANCE**
data encoded by	**=====>JAPAN**	**was decoded by**	**=====>US/NCEP and =====>JAPAN***
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.1

data encoded by	**=====>JAPAN**	**was decoded by**	**=====>ECMWF and =====>JAPAN***
data encoded by	**=====>ECMWF**	**was decoded by**	
data encoded by	**=====>US/NCEP**	**was decoded by**	

PDT 4.2

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.3

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.4

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.5

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.6

data encoded by	**=====>US/NCEP**	**was decoded by**	

PDT 4.7

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.8

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN,**
			=====>US/TDL and
			=====>ECMWF
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP**
data encoded by	**=====>ECMWF**	**was decoded by**	

PDT 4.20

data encoded by	**=====>US/NCEP**	**was decoded by**	
data encoded by	**=====>US/TDL**	**was decoded by**	

PDT 4.30

data encoded by	**=====>ECMWF**	**was decoded by**	
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>EUMETSAT**
data encoded by	**=====>EUMETSAT**	**was decoded by**	**=====>US/TDL**

Table 3: Validation of GRIB Edition 2 Data Representation Templates

DRT 5.0

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN,**
			=====>US/TDL and
			=====>ECMWF
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP and**
			=====>EUMETSAT
data encoded by	**=====>JAPAN**	**was decoded by**	**=====>US/NCEP and**
			=====>JAPAN
data encoded by	**=====>EUMETSAT**	**was decoded by**	**=====>US/TDL**
data encoded by	**=====>ECMWF**		

DRT 5.1

data encoded by

DRT 5.2

data encoded by	**=====>US/TDL**	**was decoded by**	**=====>FRANCE**
data encoded by	**=====>FRANCE**	**was decoded by**	**=====>US/TDL and**
			=====>ECMWF
data encoded by	**=====>ECMWF**	**was decoded by**	

DRT 5.3

data encoded by	**=====>US/TDL**	**was decoded by**	**=====>FRANCE**
data encoded by	**=====>FRANCE**	**was decoded by**	**=====>ECMWF and**
			=====>US/TDL
data encoded by	**=====>ECMWF**	**was decoded by**	

DRT 5.50

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

DRT 5.51

data encoded by	**=====>ECMWF**	**was decoded by**	

Table 4: Validation of GRIB Edition 2 Data Templates

DT 7.0

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>JAPAN, =====>US/TDL and =====>ECMWF**
data encoded by	**=====>US/TDL**	**was decoded by**	**=====>US/NCEP**
data encoded by	**=====>JAPAN**	**was decoded by**	**=====>US/NCEP and =====>JAPAN***
data encoded by	**=====>ECMWF**	**was decoded by**	

DT 7.1

data encoded by

DT 7.2

data encoded by	**=====>US/TDL**	**was decoded by**	**=====>FRANCE**
data encoded by	**=====>FRANCE**	**was decoded by**	**=====>US/TDL and =====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

DT 7.3

data encoded by	**=====>US/TDL**	**was decoded by**	**=====>FRANCE**
data encoded by	**=====>FRANCE**	**was decoded by**	**=====>ECMWF and =====>US/TDL**

DT 7.50

data encoded by	**=====>US/NCEP**	**was decoded by**	**=====>ECMWF**
data encoded by	**=====>ECMWF**	**was decoded by**	

DT 7.51

data encoded by	**=====>ECMWF**	**was decoded by**	

List of Grid Definition Templates

GDT 3.0: **Latitude/longitude (or equidistant cylindrical, or Plate Carree)**

GDT 3.1: **Rotated Latitude/longitude (or equidistant cylindrical, or Plate Carree)**

GDT 3.2: **Stretched Latitude/longitude (or equidistant cylindrical, or Plate Carree)**

GDT 3.3: **Stretched and Rotated Latitude/longitude (or equidistant cylindrical, or Plate Carree)**

GDT 3.10: **Mercator**

GDT 3.20: **Polar stereographic projection**

GDT 3.30: **Lambert conformal**

GDT 3.40: **Gaussian latitude/longitude**

GDT 3.41: **Rotated Gaussian latitude/longitude**

GDT 3.42: **Stretched Gaussian latitude/longitude**

GDT 3.43: **Stretched and rotated Gaussian latitude/longitude**

GDT 3.50: **Spherical harmonic coefficients**

GDT 3.51: **Rotated spherical harmonic coefficients**

GDT 3.52: **Stretched spherical harmonic coefficients**

GDT 3.53: **Stretched and rotated spherical harmonic coefficients**

GDT 3.90: **Space view perspective or orthographic**

GDT 3.100: **Triangular grid based on an icosahedron**

GDT 3.110: **Equatorial azimuthal equidistant projection**

GDT 3.120: **Azimuth-range projection**

List of Production Definition Templates

PDT 4.0: **Analysis or forecast at a horizontal level or in a horizontal layer at a point in time**

PDT 4.1: **Individual ensemble forecast, control and perturbed, at a horizontal level or in a horizontal layer at a point in time**

PDT 4.2: **Derived forecast based on all ensemble members at a horizontal level or in a horizontal layer at a point in time**

PDT 4.3: **Derived forecasts based on a cluster of ensemble members over a rectangular area at a horizontal level or in a horizontal layer at a point in time**

PDT 4.4: **Derived forecasts based on a cluster of ensemble members over a circular area at a horizontal level or in a horizontal layer at a point in time**

PDT 4.5: **Probability forecasts at a horizontal level or in a horizontal layer at a point in time**

PDT 4.6: **Percentile forecasts at a horizontal level or in a horizontal layer at a point in time**

PDT 4.7: **Analysis or forecast error at a horizontal level or in a horizontal layer at a point in time**

PDT 4.8: **Average, accumulation, and/or extreme values at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval**

PDT 4.20: **Radar product**

PDT 4.30: **Satellite Product.**

List of Data Representation Templates

DRT 5.0: **Grid point data - simple packing**

DRT 5.1: **Matrix values at grid point -simple packing**

DRT 5.2: **Grid point data - complex packing**

DRT 5.3: **Grid point data - complex packing and spatial differencing**

DRT 5.50: **Spectral data - simple packing**

DRT 5.51: **Spherical harmonics data - complex packing**

List of Data Templates

DT 7.0: **Grid point data - simple packing**

DT 7.1: **Matrix values at grid point -simple packing**

DT 7.2: **Grid point data - complex packing**

DT 7.3: **Grid point data - complex packing and spatial differencing**

DT 7.50: **Spectral data - simple packing**

DT 7.51: **Spherical harmonics - complex packing**

ANNEX TO PARAGRAPH 2.1.2

List of GRIB 2 validations to be performed:

Validations coordination to be performed by Mr Jean Clochard, Chairman of the ET on DR&C.

Centres involved:

- Australia - Melbourne (contact: Charles Sanders)
- France - Toulouse (contact: Jean Clochard - for complex packing tests)
- Japan - Tokyo (contact: Mr Atsushi Shimazaki)
- UK - Bracknell (contact: Mr Chris Long)
- USA - Washington (contact: Mr Jeff Ator, Dr Harry Glahn)
- ECMWF (contacts: John Hennessy, John Chambers)
- EUMETSAT (contact: Dr Simon Elliot)

ANNEX TO PARAGRAPH 2.1.3

Note under templates 5.1 and 7.1

This template was not validated at the time of publication and should be used with caution. Please report any use to WMO Secretariat (World Weather Watch - Basic Systems Department) to assist for validation.

ANNEX TO PARAGRAPH 2.1.4

E-mail questionnaire on GRIB 2 validation and software:

Question	Decoder	Encoder
Is your centre implementing, or do you intent to implement, a decoder or encoder for GRIB edition 2?		
If you are implementing a GRIB edition 2 encoder or decoder, are you developing your own software (so type OWN) or are you implementing software developed elsewhere (if so, please indicate the name of the originating centre)?		
If you are developing your own software, which templates do you intent to support? Please give for each (set of) template(s) the date when you expect to have support for the template available and indicate whether or not you are willing to participate in final validation tests with other centres		
What programming languages are being used for your GRIB edition 2 software?		
Which operating system and hardware platforms are being used?		
What programming languages will be supported by the Application Program Interface (API) provided by your GRIB edition 2 software?		
Are you willing to participate in efforts to standardize the API used for encoders and decoders?		

ANNEX TO PARAGRAPH 2.2.1

Draft Templates for representation of Cross sections, Hovmöller diagrams and Time sections

GRID DEFINITION TEMPLATES

Grid Definition Template 3.1000: Cross-section grid, with points equally spaced on the horizontal

Octet Numbers(s)	Contents
15-30	(same as GDT 3.0)
31-34	Number of horizontal points
35-50	(same as octets 39-54 of GDT 3.0, with reference to direction increments removed)
51	Scanning mode (flags – see Flag Table 3.4)
52-59	(same as octets 56-63 of GDT 3.0, with reference to direction increments removed)
60	Type of horizontal line (see Code Table 3.x)
61-62	Number of vertical points
63	Physical meaning of vertical coordinate (see Code Table 4.5)
64	Vertical dimension coordinate values definition (see Code Table 3.y)
65-66	NC - Number of coefficients or values used to specify vertical coordinates
67-(66+NC*4)	Coefficients to define vertical dimension coordinate values in functional form, or the explicit coordinate values (IEEE 32-bit floating-point values)

Code Table 3.x: Type of horizontal line

Code figure	Meaning
0	Rhumb
1	Great circle
2-191	Reserved
192-254	Reserved for local use
255	Missing

Code Table 3.y: Vertical dimension coordinate values definition (same as 5.2)

Grid Definition Template 3.1100: Hovmöller diagram grid, with points equally spaced on the horizontal

Octet Numbers(s)	Contents
15-60	(same as GDT 3.1000)
61-64	NT – Number of time steps
65	Unit of offset from reference time (see Code Table 4.4)
66-69	Offset from reference of first time (negative value when first bit set)
70	Type of time increment (see Code Table 4.11)
71	Unit of time increment (see Code Table 4.4)
72-75	Time increment (negative value when first bit set)
76-82	Last date/time (same as octets 35-41 in PDT 4.8)

Grid Definition Template 3.1200: Time section grid

Octet Numbers(s)	Contents
15-36	(same as octets 61-82 of GDT 3.1100)
37-(42+NC*4)	(same as octets 61-(66+NC*4) of GDT 3.1000)

PRODUCT DEFINITION TEMPLATES

Product Definition Template 4.1000: Cross section of analysis and forecast at a point in time

Octet Numbers(s)	Contents
10-22	(same as PDT 4.0)

Product Definition Template 4.1001: Cross section of averaged or otherwise statistically processed analysis or forecast over a range of times

Octet Numbers(s)	Contents
10-22	(same as PDT 4.0)
23-26	(same as octets 43-46 in PDT 4.8)
27-38	(same as octets 47-58 in PDT 4.8)

Product Definition Template 4.1002: Cross-section of analysis and forecast, averaged or otherwise statistically processed over latitude or longitude

Octet Numbers(s)	Contents
10-22	(same as PDT 4.0)
23	Horizontal dimension processed (see Code Table 4.z)
24	Treatment of missing data (e.g. below ground) (see Code Table 4.a)
25	Type of statistical processing (see Code Table 4.10)
26-29	Start of range
30-33	End of range
34-35	Number of values

Code Table 4.z: Horizontal dimension processed

Code figure	Meaning
0	Latitude
1	Longitude
2-191	Reserved
192-254	Reserved for local use
255	Missing

Code Table 4.a: Treatment of missing data

Code figure	Meaning
0	Not included
1	Extrapolated
2-191	Reserved
192-254	Reserved for local use
255	Missing

Product Definition Template 4.1100: Hovmöller-type grid with no averaging or other statistical processing

Octet Numbers(s)	Contents
10-34	(same as PDT 4.0)

Product Definition Template 4.1101: Hovmöller-type grid with averaging or other statistical processing

Octet Numbers(s)	Contents
10-34	(same as PDT 4.1100)
35-38	Total number of data values missing in the statistical process
39	Statistical process used … (see Code Table 4.10)
40	Type of time increment between successive … (see Code Table 4.11)
41	Indicator of unit of time for range … (see Code Table 4.4)
42-45	Length of the time range over which …
46	Indicator of unit of time for increment … (see Code Table 4.4)
47-50	Time increment between …

(Octets 35-50 very similar to octets 43-58 of PDT 4.8, but meaning of some fields slightly different from. ***TO BE EXPLICITED****. Reference = reference time (section 1) + forecast range (PDT) + offset and increments from reference time (GDT)… modifications to Note (2) in 4.8)*

ANNEX to paragraph 2.3.1

Proposed modification in Grid Definition Template 3.120

The last three lines of Grid Definition Template 3.120 are modified as listed below:

Grid Definition Template 3.120: Azimuth-range projection

Octet Number(s)	Contents
15-18	Nb - number of data bins along radials (see Note (1))
19-22	Nr - number of radials
23-26	La1 - latitude of center point
27-30	Lo1 - longitude of center point
31-34	Dx - spacing of bins along radials
35-38	Dstart - offset from origin to inner bound
39 - (38+4Nr)	For each of Nr radials:
	(39+4(X-1)) - (40+4(X-1)) Azi - starting azimuth, degree x 10 (degrees as north)
	(41+4(X-1)) - (42+4(X-1)) Adelta - azimuthal width, degrees x 100, (+ clockwise, - counterclockwise)
	with X = 1 to Nr

Note:
(1) A data bin is a data point representing the volume centered on it.

ANNEX TO PARAGRAPH 2.3.2

New entries for Code table 3.2 Shape of the Earth

Code figure	Meaning
…	
4	Earth assumed oblate shperoid as defined in IAG-GRS80 model (major axis = 6378137.0 m, minor axis = 6356752.314 m, f = 1/298.257222101)
5	Earth assumed represented by WGS84 (as used by ICAO since 1998)
6	Earth assumed spherical with radius of 6371229 m
7-191	Reserved
…	

Note: WGS84 is a geodetic system that uses IAG-GRS80 as basis.

ANNEX TO PARAGRAPH 3.1.1

Additional entries for icing in the BUFR flag table 0 20 021

Comparison of entries of flag table 0 20 021 with entries of 0 20 003 (present weather) has shown that all types of icing are not represented sufficiently in the flag table 0 20 021.

Proposed modifications and additions to the flag table 0 20 021 are written in bold:

0 20 021	Type of precipitation	Flag table	0	0	**30**
B 20 021			0	0	**10**

Flag Table	0 20 021 Type of precipitation
1	Precipitation-unknown type
2	Liquid precipitation not freezing
3	Liquid freezing precipitation
4	Drizzle
5	Rain
6	Solid precipitation
7	Snow
8	Snow grains
9	Snow pellets
10	Ice pellets
11	Ice crystals
12	Diamond dust
13	Small hail
14	Hail
15	Glaze
16	Rime
17	**Soft rime**
18	**Hard rime**
19	**Clear ice**
20	**Wet snow**
21	Hoar frost
22	Dew
23-29	Reserved
All 30	Missing value

Note: Mixed precipitation is indicated by setting to one the bits of all observed single types of precipitation.

ANNEX TO PARAGRAPH 3.1.5

New descriptors:

0 07 030	Height above mean sea level of station ground(1)	m	1	- 4000	17
0 07 031	Height above mean sea level of sensor	m	1	- 4000	17
0 07 032	Height of sensor above local ground(2)	m	2	0	12

Notes:

(1) The Height above mean sea level of station ground is defined as the height above mean sea-level of the ground on which the raingauge stands or, if there is no raingauge, the ground beneath the thermometer screen. If there is neither raingauge nor screen, it is the average level of terrain in the vicinity of the station (Reference: Guide to Meteorological Instruments and Methods of Observation, WMO-No. 8. 1996).

(2) Height of sensor above local ground is the actual height above ground at the point where the sensor is located (not necessarily above the level specified by 0 07 030 – Height above mean sea level of station ground).

Notes to be added:

Notes will be added to existing descriptors 0 07 001 and 0 07 006:

For 0 07 001:

This descriptor has been used mostly (archived data) to store the value of HP (as defined in Observing Stations, WMO Publication No. 9, Volume A): the elevation of the station in metres. It is the datum level to which barometric reports at the station refer. Sometimes, it has also been used to indicate H, elevation of the ground (average level of terrain in immediate vicinity of station), given for stations not located on aerodromes. It is not recommended to use this descriptor, but to use instead, 0 07 030 or 0 07 031 as appropriate.

For 0 07 006:

Descriptor 0 07 032 should be used in preference to 0 07 006.

New descriptors (specially needed for the AWS)

0 26 020	Duration of precipitation	Minute	0	0	11

0	02	175	Method of precipitation measurement	Code table	0	0	4
0	02	176	Method of state of ground measurement	Code table	0	0	4
0	02	177	Method of snow depth measurement	Code table	0	0	4
0	02	178	Method of liquid content measurement of precipitation	Code table	0	0	4

0	02	179	Type of sky condition algorithm	Code table	0	0	4
0	02	180	Main present weather detecting system	Code table	0	0	4
0	02	181	Supplementary present weather sensor	Flag table	0	0	21
0	02	182	Visibility measurement system	Code table	0	0	4
0	02	183	Cloud detection system	Code table	0	0	4
0	02	184	Type of lightning detection sensor	Code table	0	0	4
0	02	185	Method of evaporation measurement	Code table	0	0	4
0	02	186	Capability to detect precipitation phenomena *(based on flag table 0 20 021)*	Flag table	0	0	30
0	02	187	Capability to detect other weather phenomena *(based on flag table 0 20 023)*	Flag table	0	0	18
0	02	188	Capability to detect obscuration *(based on flag table 0 20 025)*	Flag table	0	0	21
0	02	189	Capability to discriminate lightning strikes	Flag table	0	0	12
0	08	010	Surface qualifier (temperature data)	Code table	0	0	4
0	33	005	Quality information (AWS data)	Flag table	0	0	30
0	33	006	Internal measurement status information (AWS)	Code table	0	0	3

0 02 175

Method of precipitation measurement

Code figure	Method of precipitation measurement
0	Manual measurement
1	Tipping bucket method
2	Weighing method
3	Optical method
4	Pressure method
5	Float method
6	Drop counter method
7-13	Reserved
14	Others
15	Missing value

0 02 176

Method of state of ground measurement

Code figure	Method of state of ground measurement
0	Manual observation
1	Video camera method
2	Infra-red method
3	Laser method
4-13	Reserved
14	Others
15	Missing value

0 02 177

Method of snow depth measurement

Code figure	Method of snow depth measurement
0	Manual observation
1	Ultrasonic method
2	Video camera method
3-13	Reserved
14	Others
15	Missing value

0 02 178

Method of liquid content measurement of precipitation

Code figure	Method of liquid content measurement of precipitation
0	Manual observation
1	Optical method
2	Capacitive method
3-13	Reserved
14	Others
15	Missing value

0 02 179

Type of sky condition algorithm

Code figure	Type of sky condition algorithm
0	Manual observation
1	VAISALA algorithm
2	ASOS (FAA) algorithm
3	AWOS (Canada) algorithm
4-13	Reserved
14	Others
15	Missing value

0 02 180

Main present weather detecting system

Code Figure	Main present weather detecting system
0	Manual observation
1	Optical scatter system combined with precipitation occurrence sensing system
2	Forward and/or back-scatter system of visible light
3	Forward and/or back-scatter system of infrared light
4	Infrared light emitting diode (IRED) system
5	Doppler radar system
6-13	Reserved
14	Others
15	Missing value

0 02 181

Supplementary present weather sensor

Bit No.	Supplementary present weather sensor
1	Rain detector
2	Freezing rain sensor
3	Ice detection sensor
4	Hail and ice pellet sensor
5-19	Reserved
20	Others
All 21	Missing value

0 02 182

Visibility measurement system

Code figure	Visibility measurement system
0	Manual measurement
1	Transmissometer system (base 25 m)
2	Transmissometer system (base < 25 m)
3	Forward scatter system
4	Back scatter system
5-13	Reserved
14	Others
15	Missing value

0 02 183

Cloud detection system

Code figure	Cloud detection system
0	Manual observation
1	Ceilometer system
2	Infrared camera system
3	Microwave visual camera system
4	Sky imager system
5	Video time lapsed camera system
6	Micro pulse lidar (MPL) system
7-13	Reserved
14	Others
15	Missing value

0 02 184

Type of lightning detection sensor

Code figure	Type of lightning detection sensor
0	Manual observation
1	Lightning imaging sensor
2	Electrical storm identification sensor
3	Magnetic finder sensor

4	Lightning strike sensor
5	Flash counter
6-13	Reserved
14	Others
15	Missing value

0 02 185

Method of evaporation measurement

Code Figure	Method of evaporation measurement
0	Manual measurement
1	Balanced floating method
2	Pressure method
3	Ultrasonic method
4	Hydraulic method
5-13	Reserved
14	Others
15	Missing value

0 02 189

Capability to discriminate lightning strikes

Bit No.	Capability to discriminate lightning strikes
1	Manual observation
2	All lightning strikes without discrimination
3	Lightning strikes cloud to ground only
4	All lightning strikes with discrimination between cloud to ground and cloud to cloud
5-11	Reserved
All 12	Missing value

0 08 010

Surface qualifier (temperature data)

Code figure	Surface qualifier (temperature data)
0	Reserved
1	Bare soil
2	Bare rock
3	Land grass cover
4	Water (lake, sea)
5	Flood water underneath
6	Snow
7	Ice
8	Runway or road
9-14	Reserved
15	Missing value

0 33 005

Quality Information (AWS data)

Bit No.	Quality Information (AWS data)
1	No automated meteorological data checks performed
2	Pressure data suspect
3	Wind data suspect
4	Dry-bulb temperature data suspect
5	Wet-bulb temperature data suspect
6	Humidity data suspect
7	Ground temperature data suspect
8	Soil temperature (depth 1) data suspect
9	Soil temperature (depth 2) data suspect
10	Soil temperature (depth 3) data suspect
11	Soil temperature (depth 4) data suspect
12	Soil temperature (depth 5) data suspect
13	Cloud data suspect
14	Visibility data suspect
15	Present weather data suspect
16	Lightning data suspect
17	Ice deposit data suspect
18	Precipitation data suspect
19	State of ground data suspect
20	Snow data suspect
21	Water content data suspect
22	Evaporation/evapotranspiration data suspect
23	Sunshine data suspect
24-29	Reserved
All 30	Missing value

0 33 006

Internal measurement status information (AWS)

Code figure	Internal measurement status information (AWS)
0	Self-check OK
1	At least one Warning active, no Alarms
2	At least one Alarm active
3	Sensor failure
4-6	Reserved
7	Missing value

Proposal for BUFR templates for AWS data

1. A BUFR template for AWS data from n-minute period

0 01 015		Station or site name	CCITT IA5
3 01 001	0 01 001	WMO block number	Numeric
	0 01 002	WMO station number	Numeric
0 02 001		Type of station	Code table
3 01 011	0 04 001	Year	Year
	0 04 002	Month	Month
	0 04 003	Day	Day
3 01 012	0 04 004	Hour	Hour
	0 04 005	Minute	Minute
3 01 021	0 05 001	Latitude (high accuracy)	Degree, scale 5
	0 06 001	Longitude (high accuracy)	Degree, scale 5
0 07 030		Height above mean sea level of station ground	m, scale 1
0 08 010		Surface qualifier (temperature data)	Code table
0 02 180		Main present weather detecting system	Code table
0 02 181		Supplementary present weather sensor	Flag table
0 02 182		Visibility measurement system	Code table
0 02 183		Cloud detection system	Code table
0 02 184		Type of lightning detection sensor	Code table
0 02 179		Type of sky condition algorithm	Code table
0 02 186		Capability to detect precipitation phenomena	Flag table
0 02 187		Capability to detect other weather phenomena	Flag table
0 02 188		Capability to detect obscuration	Flag table
0 02 189		Capability to discriminate lightning strikes	Flag table
0 04 025		Time displacement (= - n minutes)	Minute
0 04 065		Short time increment (= 1 minute)	Minute
1 42 000		Delayed replication of 42 descriptors	
0 31 001		Delayed descriptor replication factor (= n) *(n represents number of replications)*	Numeric
0 07 031		Height above mean sea level of sensor	m, scale 1
0 10 004		Pressure	Pa, scale –1
0 07 032		Height of sensor above local ground	m, scale 2
0 11 001		Wind direction	Degree true
0 11 002		Wind speed	m s^{-1}
0 11 043		Maximum wind gust direction	Degree true
0 11 041		Maximum wind speed (gusts)	m s^{-1}
0 11 016		Extreme counterclockwise wind direction of a variable wind	Degree true
0 11 017		Extreme clockwise wind direction of a variable wind	Degree true
0 07 032		Height of sensor above local ground	m, scale 2
0 12 101		Temperature/dry-bulb temperature (scale 2)	K, scale 2
0 12 103		Dew-point temperature (scale 2)	K, scale 2
0 13 003		Relative humidity	%
0 07 032		Height of sensor above local ground	m, scale 2
0 12 101		Temperature/dry-bulb temperature (scale 2) (for ground temperature)	K, scale 2

0 07 061	Depth below land surface	m, scale 2
0 12 130	Soil temperature (scale 2)	K, scale 2
0 07 061	Depth below land surface	m, scale 2
0 12 130	Soil temperature (scale 2)	K, scale 2
0 07 061	Depth below land surface	m, scale 2
0 12 130	Soil temperature (scale 2)	K, scale 2
0 07 061	Depth below land surface	m, scale 2
0 12 130	Soil temperature (scale 2)	K, scale 2
0 07 061	Depth below land surface	m, scale 2
0 12 130	Soil temperature (scale 2)	K, scale 2
0 20 010	Cloud cover (total)	%
0 33 041	Attribute of following value	Code table
0 20 013	Height of base of cloud	m, scale -1
0 20 051	Amount of low clouds	%
0 20 052	Amount of middle clouds	%
0 20 053	Amount of high clouds	%
0 33 041	Attribute of following value	Code table
0 20 001	Horizontal visibility	m, scale –1
0 20 021	Type of precipitation	Flag table
0 20 022	Character of precipitation	Code table
0 13 055	Intensity of precipitation	$kgm^{-2}s^{-1}$,scale 4
0 13 058	Size of precipitation element	m, scale 4
0 26 020	Duration of precipitation(2)	Minute
0 20 023	Other weather phenomena	Flag table
0 20 024	Intensity of phenomena	Code table
0 20 025	Obscuration	Flag table
0 20 026	Character of obscuration	Code table
	(end of the sequence of 42 descriptors)	
0 20 031	Ice deposit (thickness)	m, scale 2
0 20 032	Rate of ice accretion	Code table
0 02 175	Method of precipitation measurement	Code table
0 02 185	Method of evaporation measurement	Code table
0 02 176	Method of state of ground measurement	Code table
0 20 062	State of ground (with or without snow)	Code table
0 02 177	Method of snow depth measurement	Code table
0 13 013	Total snow depth	m, scale 2
0 02 178	Method of liquid water content measurement of precipitation	Code table
0 04 025	Time period or displacement (= - n minutes)	Minute
0 13 011	Total precipitation / total water equivalent of snow	kg m^{-2}, scale 1
0 04 025	Time period or displacement (= - n minutes)	Minute
0 13 033	Evaporation /evapotranspiration	kg m^{-2}
0 04 025	Time period or displacement (= - n minutes)	Minute
0 14 031	Total sunshine	Minute
0 08 023	First order statistics (= 10; standard deviation)	Code table
0 10 004	Pressure	Pa, scale –1
0 11 001	Wind direction	Degree true
0 11 002	Wind speed	m s^{-1}
0 12 101	Temperature/dry-bulb temperature (scale 2)	K, scale 2
0 13 003	Relative humidity	%

0 20 001	Horizontal visibility	m, scale –1
0 08 023	First order statistics (= missing value)	Code table
0 33 005	Quality information (AWS data)	Flag table
0 33 006	Internal measurement status information (AWS)	Code table

Notes: (1) The time identification refers to the end of the n-minute period.

(2) Duration of precipitation (in minutes) represents number of minutes in which any precipitation was registered.

2. A BUFR template for AWS data from 10-minute period

AWS data from a 10-minute period may be represented by the BUFR template shown 1 using n = 10. If, however, one wishes to emphasise the 10-minute period as a mandatory feature, the template in 1 might be slightly modified replacing

1 42 000	Delayed replication of 42 descriptors
0 31 001	Delayed descriptor replication factor (= n) *(n represents number of replications)*

by

1 42 010	Replication of 42 descriptors 10-times

and to use **10** for all **n** in the template in 1.

ANNEX TO PARAGRAPH 3.2.2

BUFR Template for SYNOP

301001 - WMO block and station number
001003 - WMO region number
002001 - Type of station
301011 - Date
301012 - Time
301021 - Latitude and longitude (high accuracy)
007030 - Height of station ground above MSL
007031 - Height of barometer above MSL
302001 - Pressure and pressure change
010062 - 24-hour pressure change
007004 - Pressure (standard level)
010009 - Geopotential height
007032 - Height of thermometer above ground
012101 - Dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
013003 - Relative humidity
007030 - Height of station ground above MSL (redefine height to previous value)
302004 - General cloud information
101004 - Replicate next 1 descriptor 4 times
302005 - Cloud layer information
013013 - Total snow depth
012113 - Ground minimum temperature (scale 2), past 12 hours
020003 - Present weather
013055 - Intensity of precipitation
020001 - Horizontal visibility
020002 - Vertical visibility
020021 - Type of precipitation
020022 - Character of precipitation
020023 - Other weather phenomena
020024 - Intensity of phenomena
020025 - Obscuration
020026 - Intensity of obscuration
020062 - State of ground
013023 - Total precipitation past 24 hours
102002 - Replicate next 2 descriptors 2 times
004024 - Time period in hours
013011 - Total precipitation
004024 - Time period in hours
002004 - Type of instrument for evaporation or crop type for evapotranspiration
013033 - Evaporation/evapotranspiration
004024 - Time period in hours
020004 - Past weather (1)
020005 - Past weather (2)
004024 - Time period in hours
014031 - Total sunshine

004025 - Time period in minutes
014002 - Long-wave radiation, integrated over period specified
014004 - Short-wave radiation, integrated over period specified
014016 - Net radiation, integrated over period specified
014028 - Global solar radiation, integrated over period specified
014029 - Diffuse solar radiation, integrated over period specified
014030 - Direct solar radiation, integrated over period specified
007032 - Height of thermometer above ground
101000 - Delayed replication of 1 descriptor - see Note 1 below
031001 - Delayed descriptor replication factor
004024 - Time period in hours
012111 - Maximum temperature (scale 2) at height and over period specified
004024 - Time period in hours
012112 - Minimum temperature (scale 2) at height and over period specified
007032 - Height of anemometer above ground
002002 - Type of instrumentation for wind measurement
008021 - Time significance (value = “2" (time averaged))
004025 - Time period in minutes
011001 - Wind direction
011002 - Wind speed
008021 - Time significance (value = “missing")
103002 - Replicate next 3 descriptors 2 times
004025 - Time period in minutes
011043 - Maximum wind gust direction
011041 - Maximum wind gust speed

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). Thus, in these cases, a delayed replication factor of 2 may be used to construct a time range. Conversely, in all other cases, a delayed replication factor of 1 is sufficient.
2. 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.
3. A method needs to be developed of reporting, within BUFR, the cloud information within Section 4 (i.e. clouds with bases below station level), and such descriptors should then be added to the above template.

BUFR Template for SHIP

301036 - Identification, movement, type, date/time, position (coarse accuracy)
007030 - Height of station above MSL
007031 - Height of barometer above MSL
302001 - Pressure and pressure change
010062 - 24-hour pressure change
007004 - Pressure (standard level)
010009 - Geopotential height
007032 - Height of thermometer above ground
012101 - Dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
013003 - Relative humidity
007030 - Height of station above MSL (redefine height to previous value)
302004 - General cloud information
101004 - Replicate next 1 descriptor 4 times
302005 - Cloud layer information
020003 - Present weather
013055 - Intensity of precipitation
020001 - Horizontal visibility
020002 - Vertical visibility
020021 - Type of precipitation
020022 - Character of precipitation
020023 - Other weather phenomena
020024 - Intensity of phenomena
020025 - Obscuration
020026 - Intensity of obscuration
020031 - Ice deposit (thickness)
020032 - Rate of ice accretion
020033 - Cause of ice accretion
020034 - Sea ice concentration
020035 - Amount and type of ice
020036 - Ice situation
020037 - Ice development
020038 - Bearing of ice edge
002038 - Method of sea-surface temperature measurement
022043 - Sea/water temperature (scale 2)
302021 - Waves
302024 - Wind waves and swell waves
013023 - Total precipitation past 24 hours
102002 - Replicate next 2 descriptors 2 times
004024 - Time period in hours
013011 - Total precipitation
004024 - Time period in hours
020004 - Past weather (1)
020005 - Past weather (2)
007032 - Height of thermometer above ground
101000 - Delayed replication of 1 descriptor - see Note 1 below
031001 - Delayed descriptor replication factor

004024 - Time period in hours
012111 - Maximum temperature (scale 2) at height and over period specified
004024 - Time period in hours
012112 - Minimum temperature (scale 2) at height and over period specified
007032 - Height of anemometer above ground
002002 - Type of instrumentation for wind measurement
008021 - Time significance (value = “2" (time averaged))
004025 - Time period in minutes
011001 - Wind direction
011002 - Wind speed
008021 - Time significance (value = “missing")
103002 - Replicate next 3 descriptors 2 times
004025 - Time period in minutes
011043 - Maximum wind gust direction
011041 - Maximum wind gust speed

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). Thus, in these cases, a delayed replication factor of 2 may be used to construct a time range. Conversely, in all other cases, a delayed replication factor of 1 is sufficient.
2. 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.

BUFR Template for XBT/XCTD

001003 - WMO region
001020 - WMO region sub-area
001005 - Buoy/platform identifier
001011 - Ship call sign
001019 - Ship name
001YYY - (a unique observation identifier - to be defined later by DBCP/SOOP)
001080 - Ship line number according to SOOP
005036 - Ship transect number according to SOOP
001036 - Agency in charge of operating the observing platform
301011 - Date
301012 - Time
301021 - Latitude and longitude (high accuracy)
007030 - Height of station above MSL
002040 - Method of removing platform direction and speed from current
022067 - Instrument type for water temperature profile measurement
022068 - Water temperature profile recorder type
025100 - XBT/XCTD fall rate equation coefficient a
025101 - XBT/XCTD fall rate equation coefficient b
022063 - Total depth of water
302021 - Waves
306004 - Sea temperature and salinity profile
002030 - Method of current measurement
306005 - Time/duration of current measurement, depths/directions/speeds
007032 - Height of thermometer above ground
012101 - Dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
007032 - Height of anemometer above ground
011001 - Wind direction
011002 - Wind speed

BUFR Template for subsurface profiling floats

001003 - WMO region
001020 - WMO region sub-area
001005 - Buoy/platform identifier
001085 - Observing platform manufacturers model
001086 - Observing platform manufacturers serial number
002036 - Buoy type
002149 - Type of data buoy
301011 - Date
301012 - Time
301021 - Latitude and longitude (high accuracy)
007030 - Height of station above MSL
002040 - Method of removing platform direction and speed from current
022067 - Instrument type for water temperature profile measurement
022068 - Water temperature profile recorder type
033YYY - (Quality flags - see Note 1 below)
022055 - Float cycle number
022056 - Direction of profile
022063 - Total depth of water
302021 - Waves
002032 - Indicator for digitization
002033 - Method of salinity/depth measurement
103000 - Delayed replication of 3 descriptors
031001 - Delayed descriptor replication factor
007062 - Depth below sea surface
022045 - Subsurface sea temperature (scale 3)
022064 - Salinity (scale 3)
002030 - Method of current measurement
306005 - Time/duration of current measurement, depths/directions/speeds
007032 - Height of thermometer above ground
012101 - Dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
007032 - Height of anemometer above ground
011001 - Wind direction
011002 - Wind speed

Notes:
1. Referring to the paper provided by Etienne Charpentier, in which it is noted that quality flags relating to four different types of profiles are required to be reported, it seems that the best approach would be to implement the repeated use of operator 204004 along with descriptor 031021 in order to add the required 4 bits of quality information for each profile, rather than defining four separate class 33 code tables each with identical entries. However, the details of how exactly to implement such an approach must still be worked out and then added to the above template.

BUFR Template for BUOY

001003 - WMO region
001020 - WMO region sub-area
001005 - Buoy/platform identifier
002001 - Type of station
002036 - Buoy type
002149 - Type of data buoy
301011 - Date
301012 - Time
008021 - Time significance (value = “26" (time of last known position))
301011 - Date
301012 - Time
008021 - Time significance (value = "missing")
301021 - Latitude and longitude (high accuracy)
027004 - Alternate latitude (high accuracy)
028004 - Alternate longitude (high accuracy)
007030 - Height of station above MSL
001051 - Platform Transmitter ID (CCITT IA5)
002148 - Data collection and/or Location system
001012 - Platform drift direction
001014 - Platform drift speed
002040 - Method of removing platform direction and speed from current
033022 - Quality of buoy satellite transmission
033023 - Quality of buoy location
033027 - Location quality class (range of radius of 66% confidence)
022063 - Total water depth
302021 - Waves
302022 - Wind waves
302023 - Swell waves
025025 - Battery voltage
002034 - Drogue type
007070 - Drogue depth
002190 - Lagrangian drifter submergence
025086 - Depth correction indicator
002035 - Cable length
002168 - Hydrostatic pressure of lower end of cable
020031 - Ice deposit (thickness)
306004 - Digitization, depth/salinity method, depths/salinities/temperatures
002030 - Method of current measurement
306005 - Time/duration of current measurement, depths/directions/speeds
007031 - Height of barometer above MSL
302001 - Pressure and pressure change
007032 - Height of thermometer above ground
012101 - Dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
013003 - Relative humidity
007032 - Height of anemometer above ground
002169 - Anemometer type

002002 - Type of instrumentation for wind measurement
008021 - Time significance (value = “2" (time averaged))
004025 - Time period in minutes
011001 - Wind direction
011002 - Wind speed
008021 - Time significance (value = "missing”)
004025 - Time period in minutes
011043 - Maximum wind gust direction
011041 - Maximum wind gust speed
007030 - Height of station above MSL (redefine height to previous level)
004024 - Time period in hours
013011 - Total precipitation
008021 - Time significance (value = “3" (accumulated))
004024 - Time period in hours
014021 - Global radiation, integrated over period specified
008021 - Time significance (value = "missing”)

BUFR Template for AMDAR

001006 - Aircraft identifier
002061 - Aircraft navigational system
301011 - Year, month, and day
301013 - Hour, minute, and second
301021 - Latitude and longitude (high accuracy)
008004 - Phase of aircraft flight
007002 - Height or altitude
002062 - Type of aircraft data relay system
002005 - Precision of temperature observation
012101 - Temperature/dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
013003 - Relative humidity
011001 - Wind direction
011002 - Wind speed
011031 - Degree of turbulence
011036 - Maximum derived equivalent vertical gust speed

Notes:
1. A method needs to be developed of reporting, within BUFR, the flight level value within Section 3, and such descriptor(s) should then be added to the above template. Note that this is not the same as the altitude value within Section 2, which is itself stored as 007002 in the above template.

BUFR Template for AIREP

001006 - Aircraft identifier
301011 - Date
301012 - Time
301021 - Latitude and longitude (high accuracy)
007002 - Height or altitude
012101 - Temperature/dry-bulb temperature (scale 2)
011001 - Wind direction
011002 - Wind speed
011031 - Degree of turbulence
020041 - Airframe icing

BUFR Template for radiosonde by pressure

301001 - WMO block and station number
001011 - Ship or mobile land station identifier
001006 - Aircraft identifier (for dropsondes)
002011 - Radiosonde type
002013 - Solar and infrared radiation correction
002014 - Tracking technique/status of system used
002003 - Type of measuring equipment used
301011 - Date
004004 - Hour
008021 - Time significance (value ="18" (radiosonde launch time))
301011 - Date
301012 - Time
008021 - Time significance (set to "missing" to turn off previous significance)
301021 - Latitude and longitude (high accuracy)
007030 - Height of station ground above MSL
007031 - Height of barometer above MSL
007007 - Height of release of sonde above MSL
033024 - Station elevation quality mark (for mobile stations)
022043 - Sea/water temperature (scale 2) (for ship stations)
103003 - Replicate next 3 descriptors 3 times
020012 - Cloud type
020011 - Cloud amount
020013 - Height of base of cloud
107000 - Delayed replication of 7 descriptors
031001 - Delayed descriptor replication factor
007004 - Pressure
008001 - Vertical sounding significance
010009 - Geopotential height
012101 - Temperature/dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
011001 - Wind direction
011002 - Wind speed
007004 - Pressure
008001 - Vertical sounding significance
011061 - Absolute wind shear in 1 km layer above
011062 - Absolute wind shear in 1 km layer below

Notes:
1. The following note should be added to the flag table 008001:
“Note that all bits set to zero implies a level of undetermined significance.”

BUFR Template for radiosonde by height

301001 - WMO block and station number
001011 - Ship or mobile land station identifier
001006 - Aircraft identifier (for dropsondes)
002011 - Radiosonde type
002013 - Solar and infrared radiation correction
002014 - Tracking technique/status of system used
002003 - Type of measuring equipment used
301011 - Date
004004 - Hour
008021 - Time significance (value ="18" (radiosonde launch time))
301011 - Date
301012 - Time
008021 - Time significance (set to "missing" to turn off previous significance)
301021 - Latitude and longitude (high accuracy)
007030 - Height of station ground above MSL
007007 - Height of release of sonde above MSL
033024 - Station elevation quality mark (for mobile stations)
022043 - Sea/water temperature (scale 2) (for ship stations)
103003 - Replicate next 3 descriptors 3 times
020012 - Cloud type
020011 - Cloud amount
020013 - Height of base of cloud
106000 - Delayed replication of 6 descriptors
031001 - Delayed descriptor replication factor
007009 - Geopotential height
008001 - Vertical sounding significance
012101 - Temperature/dry-bulb temperature (scale 2)
012103 - Dew-point temperature (scale 2)
011001 - Wind direction
011002 - Wind speed
007009 - Geopotential height
008001 - Vertical sounding significance
011061 - Absolute wind shear in 1 km layer above
011062 - Absolute wind shear in 1 km layer below

BUFR Template for METAR/SPECI

The following changes are proposed to the below existing descriptor(s):

1. Instead of 307011, use the new sequence:
001063 - ICAO location indicator
002001 - Type of station
301011 - Year, month, and day
301012 - Hour and minute
301023 - Latitude and longitude (coarse accuracy)
007031 - Height of barometer above MSL
007032 - Height of anemometer above ground
011001 - Wind direction
011016 - Extreme counterclockwise wind direction of a variable wind
011017 - Extreme clockwise wind direction of a variable wind
011002 - Wind speed
011041 - Maximum wind speed (gusts)
007032 - Height of thermometer above ground
012101 - Temperature (scale 2)
012103 - Dewpoint temperature (scale 2)
010052 - Altimeter setting (QNH)
020009 - General Weather Indicator (TAF/METAR)

2. Instead of 307018, use the new sequence:
008016 - Change qualifier of a trend-type or aerodrome forecast
102000 - Delayed replication of 2 descriptors
031001 - Number of replications (up to 2)
008017 - Qualifier of the time when the forecast change is expected (FM,TL,AT)
301012 - Hour and minute
104000 - Delayed replication of 4 descriptors
031001 - Number of replications (up to 1)
007032 - Height of anemometer above ground
011001 - Wind direction
011002 - Wind speed
011041 - Maximum wind speed (gusts)
020009 - General Weather Indicator
101000 - Delayed replication of 1 descriptor
031001 - Number of replications (up to 1)
020001 - Horizontal visibility
307014 - Significant present weather sequence

3. It is recommended that descriptive names (rather than actual code figures from the METAR/SPECI code form!) be used for all descriptors, such as was done in item #2 above for 301012 and 307014 within the replacement for sequence 307018. However, the use of actual code figures within the margins, as was done below for many descriptors within 307021, seems useful for clarification as well as for educational purposes.

4. It is also recommended to not use the word “Total” within the names of any top-level descriptor templates (such as was done below for 307021), as this seems to imply that no further elements (such as those of regional or national interest) may be added after the main template, when actually the exact opposite is true.

307021 - Total sequence for representation of METAR/SPECI code in BUFR

					(Total sequence for representation of METAR/SPECI code in BUFR)	
3	07	021	3	07	011	Main part of data
			3	07	012	D_VVVVV
			3	07	013	$D_RD_RV_RV_RV_RV_R$
			3	07	014	w´w´
			3	07	015	Clouds group(s)
			3	07	016	REw´w´
			3	07	017	Wind shear on runway(s)
			3	07	018	Trend-type landing forecast
			3	07	015	Clouds group(s)

						(Main part of data for representation of METAR/SPECI code in BUFR)	
3	07	011	0	01	063	ICAO location indicator	CCCC
			0	02	001	Type of station	(AUTO)
			3	01	011	Year, month, day (YY)	
			3	01	012	GG, gg	
			3	01	024	Latitude-longitude (coarse accuracy), height of station	
			0	07	006	Height above station (= height of an anemometer)	
			0	11	001	Wind direction	ddd
			0	11	016	Extreme counterclockwise wind direction of a variable wind	$d_nd_nd_n$
			0	11	017	Extreme clockwise wind direction of a variable wind	$d_xd_xd_x$
			0	11	002	Wind speed	ff
			0	11	041	Maximum wind speed (gusts)	f_mf_m
			0	07	006	Height above station (= height of a thermometer)	
			0	12	001	Temperature	T´T´
			0	12	003	Dew-point temperature	$T´_dT´_d$
			0	10	052	Altimeter setting (QNH)	$P_HP_HP_HP_H$
			0	20	009	General Weather Indicator TAF/METAR	
						(D_VVVVV)	
3	07	012	1	03	000	Delayed replication of 3 descriptors	
			0	31	001	Number of replication (up to 3)	
			0	08	023	First order statistics	
			0	05	021	Direction of visibility observed	D_v
			0	20	001	Horizontal visibility	VVVV
						($D_RD_RV_RV_RV_RV_R$)	
3	07	013	1	06	000	Delayed replication of 6 descriptors	
			0	31	001	Number of replication (up to 4)	
			0	01	064	Runway designator	D_RD_R
			0	08	014	Qualification for runway visual range	
			0	20	061	Runway visual range	$V_RV_RV_RV_R$
			0	08	014	Qualification for runway visual range	
			0	20	061	Runway visual range	$V_RV_RV_RV_R$
			0	20	018	Tendency of runway visual range	i
						(w´w´)	
3	07	014	1	01	000	Delayed replication of 1 descriptor	
			0	31	001	Number of replication (up to 3)	
			0	20	019	Significant present weather	w´w´
						(Clouds group(s))	
3	07	015	1	01	000	Delayed replication of 1 descriptor	
			0	31	001	Number of replication	
			3	02	005	($N_sN_sN_s$, CC, $h_sh_sh_s$)	
			0	20	002	Vertical visibility	$VVh_sh_sh_s$

						(REw´w´)	
3	07	016	1	01	000	Delayed replication of 1 descriptor	
			0	31	001	Number of replication (up to 3)	
			0	20	020	Significant recent weather phenomena	REw´w´
						(Wind shear on runways(s))	
3	07	017	1	01	000	Delayed replication of 1 descriptor	
			0	31	001	Number of replication	
			0	11	070	Runway designator of the runway affected by wind shear (including ALL)	WS RWYD_RD_R
						(Trend-type landing forecast)	
3	07	018	0	08	016	Change qualifier of a trend-type	TTTTT
						forecast or an aerodrome forecast	
			1	02	000	Delayed replication of 2 descriptors	
			0	31	001	Number of replication (up to 2)	
			0	08	017	Qualifier of the time when the forecast	TT
						change is expected (FM, TL, AT)	
			3	01	012	GG, gg	
			1	04	000	Delayed replication of 4 descriptor	
			0	31	001	Number of replication (up to 1)	
			0	07	006	Height above station	
			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	
			1	01	000	Delayed replication of 1 descriptor	
			0	31	001	Number of replication (up to 1)	
			0	20	001	Horizontal visibility	VVVV
			3	07	014	w´w´	
						(Short METAR/SPECI)	
3	07	020	3	07	011	Main part of data	
			3	07	014	w´w´	
			3	07	016	REw´w´	

ANNEX TO PARAGRAPH 3.3

Additional entries in Common Code Tables

Common Code Table C-1: Originating Centres

Code figure	Centre
061	Service ARGOS - Landover
084	Toulouse (RSMC)
214	Madrid
215	Zürich
216	Service ARGOS -Toulouse

Common Code Table C-2: Radiosonde system

At the request of the CIMO Working Group on Ground Based Upper-air Observing Systems, in view of new equipment being used by Meteorological Services, some new entries are requested for new sondes and at the same time the name of some sondes are modified for clarification.

The following new entries are proposed:

54 GRAW DFM-97 (Germany)
66 Vaisala RS80 /Autosonde (Finland)
67 Vaisala RS80/Digicora III (Finland)
78 Vaisala RS90/Digicora III (Finland)
82 SIPPICAN MK2 GPS/STAR (USA)
83 SIPPICAN MK2 GPS/W9000 (USA)

The following changes to wording of existing codes are proposed:

61 Vaisala RS80/Digicora or Marwin (Finland)	to 61 Vaisala RS80/Loran/Digicora I,II or Marwin (Finland)
71 RS90/Digicora or Marwin (Finland)	to 71 Vaisala RS90/Loran/Digicora I,II or Marwin (Finland)
72 RS90/PC-CORA (Finland)	to 72 Vaisala RS90/PC-CORA (Finland)
73 RS90/Autosonde (Finland)	to 73 Vaisala RS90/Autosonde (Finland)
74 RS90/Star (Finland)	to 74 Vaisala RS90/Star (Finland)

Common Code Table C-5: Satellite identifier:

Modify entry:

171	MTSAT-1	to	171	MTSAT-1R

Common Code Table C-8: Satellite Instruments:

Delete entry 206.
Add:

207	EUMETSAT	Radiometer	SEVIRI	Spinning Enhanced Visible and Infrared Imager

ANNEX TO PARAGRAPH 3.4.1

Additional entries in code table 0-02-163

The tracers used in Eumetsat's derivation of clear sky water vapour winds from 6.7ì (WV) Meteosat image data represent the motion of a layer of atmosphere, rather than a single level. For this reason, the height assignment of the winds can be best described by giving explicit details about the form of the cumulative contribution function in the region of the tracer. Four new BUFR code table entries are required for this purpose, as per the following table.

Proposed code table entry	Meaning
9	Cumulative contribution function -10 percent height
10	Cumulative contribution function -50 percent height
11	Cumulative contribution function -90 percent height
12	Cumulative contribution function – height of maximum gradient

New significance qualifiers

As part of the generation of clear sky radiance data from Meteosat images, Eumetsat derive various quality control indicators for the radiances. These are calculated as percentage confidences and are derived independently using (i) cloud fraction, and (ii) temperature standard deviation. A final overall as percentage confidence is calculated by a combination of the other values. A method is required to represent these different pieces of quality control information unambiguously in BUFR messages.

New descriptor:

0 08 033 Method of derivation of percentage confidence Code table 0 0 7

Code figure	Meaning
0	Reserved
1	Percentage confidence calculated using cloud fraction
2	Percentage confidence calculated using standard deviation of temperature
3-126	Reserved
127	Missing

Add Note under class 8: (6) Descriptor 0 08 033 is to be used by preceding the element 0 33 007 as part of quality control information in order to specify the method used to calculate the percentage confidence.

Representation of FM 18-XI BUOY Last Known Position within BUFR/CREX

The last known position of a drifting buoy can be represented either in terms of time or location (latitude/longitude) within the FM 18-XI BUOY code form. This paper proposes a simple way to represent, via the introduction of several new descriptors, the same information within BUFR/CREX.

Additions requested in Code Table 0 08 021 Time Significance:

Code figure:	Meaning
26	Time of last known position

Additions requested in Tables B, Class 27 and Class 28**:**

	BUFR			CREX
0 27 003 Alternate latitude (coarse accuracy)	Degree	2 -9000	15	Degree 2 4
0 27 004 Alternate latitude (high accuracy)	Degree	5 -9000000	25	Degree 5 7
0 28 003 Alternate longitude (coarse accuracy)	Degree	2 -18000	16	Degree 2 5
0 28 004 Alternate longitude (high accuracy)	Degree	5 -18000000	26	Degree 5 8

Representation of Ascending vs. Descending Orbit within BUFR/CREX

Introduction of a new descriptor to represent, within BUFR/CREX class 8, whether a satellite is on an ascending or descending track:

0 08 075	Ascending/Descending Orbit Qualifier	Code table 0 0 2
B 08 075	Ascending/Descending Orbit Qualifier	Code table 0 1

Code table:

0-08-075
0 - Ascending orbit
1 - Descending orbit
2 - Reserved
3 - Missing

ANNEX TO PARAGRAPH 3.4.2

Editorial correction

The data width for BUFR descriptor 0 02 151, Radiometer identifier, be changed to 11 as an editorial amendment. The corresponding code table 0 02 151 be changed so that the last two entries read

Code
Figure

8-2046 Reserved
2047 Missing value

ANNEX TO PARAGRAPH 3.4.3

Oceanographic data

New BUFR Table B descriptors for XBT/XCTD ship observations (BATHY/TESAC)

0 01 080: Ship line number according to SOOP (4 characters, e.g. "AX01")
0 05 036: Ship transect number according to SOOP (a number [0,99] incremented for each transect modulo 100)
0 01 036: Agency in charge of operating the observing platform (Code table)
0 25 100: XBT/XCTD Fall rate equation coefficient a (Numeric, 10^{-5} resolution, range [0,9])
0 25 101: XBT/XCTD Fall rate equation coefficient b (Numeric, 10^{-5} resolution, range [-5,9])
0 01 019: Long station or site name (32 characters)
0 01 yyy: unique observation identifier: to be defined later

New BUFR Table B descriptors for sub-surface profiling floats (BATHY/TESAC)

0 22 055: Float cycle number (a number [0,999] incremented for each float cycle modulo 1000)
0 22 056: Direction of profile (Code table: up, down, horizontal)
0 01 085: Observing platform Manufacturer's model (20 characters)
0 01 086: Observing platform Manufacturer's serial number (32 characters)
0 22 045: Water temperature (10^{-3} K resolution)
0 22 064: Water Salinity (10^{-3} part per thousand resolution)
0 22 065: Water pressure Pa -3 17 Range: 0, 100000000 Pa
0 22 066: Water conductivity S/m 6 26 Range: 0, 60 S/m

The descriptors below require further study before approval:
***0 33 050**: Global GTSPP quality flag of water pressure profile (code table, 4 bits)*
***0 33 051**: Global GTSPP quality flag of water temperature profile (code table, 4 bits)*
***0 33 052**: Global GTSPP quality flag of water salinity profile (code table, 4 bits)*
***0 33 053**: Global GTSPP quality flag of water conductivity profile (code table, 4 bits)*

***(Remark**: each float profile datum, including observation time, location, surface and sub-surface data will be associated with quality information using 4 bits as associated fields consistent with proposed new entry "6: Quality Control Flag according to GTSPP" in BUFR Code/Flag Table "Associated field significance (0 31 021)". This should be considered in the template for sub-surface floats).*

New BUFR Table B descriptors for buoy data (BUOY)
0 25 025: Battery voltage (Volts, range [0,50], 10^{-1} resolution)
0 02 190: Lagrangian drifter submergence (%, 10^{0} resolution, range [0,100])

Summary of new BUFR Table B descriptors needed:

TABLE REFERENCE			ELEMENT NAME	UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (BITS)
F	X	Y					
0	01	019	Long Station or site name	CCITT IA5	0	0	256
0	01	036	Agency in charge of operating the observing platform	Code table	0	0	20
0	01	080	Ship line number according to SOOP	CCITT IA5	0	0	32
0	01	085	Observing platform Manufacturer's model	CCITT IA5	0	0	160
0	01	086	Observing platform Manufacturer's serial number	CCITT IA5	0	0	256
0	02	190	Lagrangian drifter submergence (% time submerged)	%	0	0	7
0	05	036	Ship transect number according to SOOP	Numeric	0	0	7
0	22	045	Sea/water temperature	K	3	0	19
0	22	055	Float cycle number	Numeric	0	0	10
0	22	056	Direction of Profile	Code Table	0	0	2
0	22	064	Salinity	Part per thousand	3	0	17
0	22	065	Water pressure	Pa	-3	0	17
0	22	066	Water conductivity	S/m	6	0	26
0	25	025	Battery voltage	V	1	0	9
0	25	100	XBT/XCTD fall rate equation coefficient a	Numeric	5	0	20
0	25	101	XBT/XCTD fall rate equation coefficient b	Numeric	5	-500000	21

CODE TABLES AND FLAG TABLES ASSOCIATED WITH BUFR TABLE B

Proposed new code tables associated with BUFR Table B

0 01 036

Agency in charge of operating the observing platform

(first 3 digits represent ISO country code)

Code figure	
0-36000	Reserved
036001	Australia, Bureau of Meteorology (BOM)
036002	Australia, Joint Australian Facility for Ocean Observing Systems (JAFOOS)
036003	Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO)
036004-124000	Reserved
124001	Canada, Marine Environmental Data Service (MEDS)
124002	Canada, Institute of Ocean Sciences (IOS)
124003-156000	Reserved
156001	China, The State Oceanic Administration
156002	China, Second Institute of Oceanography State Oceanic Administration
156003	China, Institute of Ocean Technology
156004-250000	Reserved
250001	France, Institut de Recherche pour le Développement (IRD)
250002	France, Institut Français de Recherche pour l'Exploitation de la mer (IFREMER)
250003-276000	Reserved
276001	Germany, Bundesamt fuer Seeschiffahrt und Hydrographie (BSH)
276002	Germany, Institut fuer Meereskunde, Kiel
276003-356000	Reserved
356001	India, National Institute of Oceanography (NIO)
356002	India, National Institute for Ocean Technology (NIOT)
356003	India, National Centre for Ocean Information Service
356004-392000	Reserved
392001	Japan, Japan Meteorological Agency (JMA)
392002	Japan, Frontier Observational Research System for Global Change
392003	Japan, Japan Marine Science and Technology Centre (JAMSTEC)
392004-410000	Reserved
410001	Korea Rep., Seoul National University
410002	Korea Rep., Korea Ocean Research and Development Institute (KORDI)
410003	Korea Rep., Meteorological Research Institute
410004-540000	Reserved
540001	New Caledonia, Institut de Recherche pour le Développement (IRD)
540002-554000	Reserved
554001	New Zealand, National Institute of Water and Atmospheric Research (NIWA)
554002-64300	Reserved
643001	Russia, State Oceanographic Institute of Roshydromet
643002	Russia, Federal Service for Hydrometeorology and Environmental Monitoring
643003-724000	Reserved
724001	Spain, Instituto Español de Oceanografia
724002-826000	Reserved
826001	United Kingdom, Hydrographic Office
826002	United Kingdom, Southampton Oceanography Centre (SOC)
826003-840000	Reserved
840001	USA, NOAA Atlantic Oceanographic and Meteorological Laboratories (AOML)
840002	USA, NOAA Pacific Marine Environmental Laboratories (PMEL)
840003	USA, Scripps Institution of Oceanography (SIO)
840004	USA, Woods Hole Oceanographic Institution (WHOI)

840005	USA, University of Washington
840006	USA, Naval Oceanographic Office
840007-1048574	Reserved
1048575	Missing

0 22 056

Direction of profile

Code figure	
0	Upwards profile
1	Downwards profile
2	Horizontal
3	Missing

Proposed new entries in code tables and flag tables associated with BUFR Table B:

0 02 036

Buoy type

Code figure	
2	Sub-surface float (moving)

0 02 149

Type of data buoy

Code figure	
26	sub-surface Argo float

0 31 021

Associated field significance

Code figure	
6	Quality Control Flag according to GTSPP: 0 = Unqualified 1 = Correct value (all checks passed) 2 = Probably good but value inconsistent with statistics (differ from climatology) 3 = Probably bad (spike, gradient, … if other tests passed) 4 = Bad value, Impossible value (out of scale, vertical instability, constant profile) 5 = Value modified during quality control 6-7 = Not used (reserved) 8 = Interpolated value 9 = Missing value

TABLES BELOW FOR FURTHER STUDY BEFORE APPROVAL:

0 33 050

Global GTSPP quality flag of water pressure profile

Code figure	
0	*Unqualified*
1	*Correct value (all checks passed)*
2	*Probably good but value inconsistent with statistics (differ from climatology)*
3	*Probably bad (spike, gradient, … if other tests passed)*
4	*Bad value, Impossible value (out of scale, vertical instability, constant profile)*
5	*Value modified during quality control*
6-7	*Reserved*
8	*Interpolated value*
9-14	*Reserved*
15	*Missing*

0 33 051

Global GTSPP quality flag of water temperature profile

Code figure	
0	*Unqualified*
1	*Correct value (all checks passed)*
2	*Probably good but value inconsistent with statistics (differ from climatology)*
3	*Probably bad (spike, gradient, … if other tests passed)*
4	*Bad value, Impossible value (out of scale, vertical instability, constant profile)*
5	*Value modified during quality control*
6-7	*Reserved*
8	*Interpolated value*
9-14	*Reserved*
15	*Missing*

0 33 052

Global GTSPP quality flag of water salinity profile

Code figure	
0	*Unqualified*
1	*Correct value (all checks passed)*
2	*Probably good but value inconsistent with statistics (differ from climatology)*
3	*Probably bad (spike, gradient, … if other tests passed)*
4	*Bad value, Impossible value (out of scale, vertical instability, constant profile)*
5	*Value modified during quality control*
6-7	*Reserved*
8	*Interpolated value*
9-14	*Reserved*
15	*Missing*

0 33 053

Global GTSPP quality flag of water conductivity profile

Code figure	
0	*Unqualified*
1	*Correct value (all checks passed)*
2	*Probably good but value inconsistent with statistics (differ from climatology)*
3	*Probably bad (spike, gradient, … if other tests passed)*
4	*Bad value, Impossible value (out of scale, vertical instability, constant profile)*
5	*Value modified during quality control*
6-7	*Reserved*
8	*Interpolated value*
9-14	*Reserved*
15	*Missing*

ANNEX TO PARAGRAPH 3.4.5

Representation of Probabilities and other Forecast Data within BUFR/CREX

1.0 Background

A division within the U.S. National Weather Service has been generating forecast model output statistics for some time now, and they would now like to widen their capability to distribute this data via the use of a well-supported and internationally recognized data format. It had been suggested that they use BUFR for this purpose, and they are agreeable to do so. At first glance, it may seem as though this is a job better suited to GRIB or GRIB 2, since this is, after all, forecast data rather than observed data. However, when one considers that the basic layout of this data consists of various parameters valid at the same data point (i.e. forecast site), rather than one single parameter valid at many various data points, the choice of BUFR is much more sensible. The problem, then, is how to describe this data using BUFR, which, owing to its historical origins as a data format primarily intended for the exchange of observed data, is currently somewhat lacking in its capability to describe non-observed data involving probabilities, statistical and categorical forecasts, and the like. In fact, the only current allowance within BUFR for describing forecast data consists primarily of a few short entries within some code tables such as 0-08-021 and 0-08-024! Notwithstanding these challenges, It is believed that this situation presents an excellent opportunity to expand the usefulness and acceptance of BUFR, and it is foreseen the possibility that other organizations may ultimately find it useful and practical to distribute their own forecast or other model output data in this way.

2. Issues to be resolved

2.1 Probability

Other than the recently-established Table B descriptor 0-21-120, there is no methodology available within BUFR to describe the probability of the occurrence of a specified event at a given data point. Following are some examples of items that we would like to be able to report:

the probability that a thunderstorm will occur within a specified time frame (e.g. the probability that a thunderstorm will occur during the previous 6 hours prior to the forecast time)

the probability that precipitation will exceed a certain amount during a specified time frame (e.g. the probability of precipitation >= 0.1 kg/m**2 during the previous 6 hours prior to the forecast time)

the probability that the maximum wind speed will fall within each of several distinct ranges during a specified time frame (e.g. the probability that the maximum wind speed during the previous 12 hours prior to the forecast time will be between 0-10 m/s, the probability that it will be between 11-20 m/s, the probability that it will be between 21-30 m/s, etc.)

the probability that visibility will not exceed each of several distinct thresholds (e.g. the probability that visibility <= 0.5 km, the probability that it will be < 1 km, etc.)

However, given that (1) probability is always reportable in units of percent (i.e. scale = reference value = 0, bit width = 7), and (2) descriptors already exist within BUFR for most of the commonly-reported meteorological parameters such as in the above examples, and (3) specification of time periods is already well-defined in BUFR, it seems that a generic solution to this issue is possible. One possibility is an approach whereby a single generic Table B descriptor is created with name "Probability of following descriptor with respect to specified value" and whose value is the forecasted probability value in question, and where the following descriptor then defines both the meteorological parameter to which the probability value applies as well as the corresponding threshold (if any). We could even expand such a scenario to allow for the possibility of two identical following descriptors appearing adjacently, and

where the two corresponding threshold values would then be understood to denote the bounds of a range in which the associated meteorological parameter must fall, similar to how regulation 94.5.3.4 allows the definition of ranges for descriptors in classes 4-7! In either case, we would probably also need one additional (Class 8 qualifier?) descriptor to signify the relationship between the probability value and the threshold value(s) (e.g. <, <=, >=, etc.). For example, if we denote the hypothetical new probability descriptor as 0-XX-YYY and the hypothetical new relationship qualifier as 0-xx-yyy, then the descriptor sequence:

0-XX-YYY with corresponding value 30
0-xx-yyy with corresponding code figure for "<"
0-20-001 with corresponding value 500

would denote that there is a 30% probability of the horizontal visibility being less than 500m (=0.5km). Similarly, the descriptor sequence:

0-XX-YYY with corresponding value 50
0-20-003 with corresponding code figure 190 for "Thunderstorm"

would denote that there is a 50% chance of a thunderstorm. And, finally, the descriptor sequence:

0-XX-YYY with corresponding value 25
0-xx-yyy with corresponding code figure for ">="
0-xx-yyy with corresponding code figure for "<"
0-11-046 with corresponding value 11
0-11-046 with corresponding value 20

would denote that there is 25% chance that the maximum instantaneous wind speed will be >= 11 m/s and < 20 m/s.

In each of the above cases, note that we could further precede the relevant descriptor sequence with appropriate class 4 descriptors to denote, in the usual BUFR manner, the time (or time range) applicable to each event. Note also that, since we are using already-existing Table B descriptors to contain the relevant threshold values for each meteorological parameter, the corresponding units of each of the threshold values are already well-defined, and we also are guaranteed to be able to store any plausible threshold value for that meteorological parameter, since the corresponding descriptor itself presumably was originally defined with the proper scale, reference value, and bit width in order to be able to contain any plausible value for that meteorological parameter!

2.2 Conditional Probability

Additionally, it would be desirable to develop some methodology to be able to report conditional probability (e.g. Assuming that there is precipitation, what is the probability that it is in the form of snow? Alternatively, what is the probability that it is in the form of rain?). However, we do not ourselves, at the present time, have any suggestions or preferences on how to do this.

2.3 Categorical Forecasts

Additionally, it would be desirable to develop some methodology to be able to report categorical forecasts. These are cases where the forecast is presented in terms of a "best guess" from among several mutually-exclusive yet related categories, rather than in terms of a numerical probability value. Such categories are often best defined using code tables, as in the following examples:

0-??-??? Quantitative Snow Amount Forecast (Categorical)

Code Figure	
0	No snow
1	Trace
2	< .04 m
3	>= .04 m and < .09m
4	>= .09 m and < .13m
5	>= .13 m and < .18m
6-14	Reserved
15	Missing

0-??-??? Character of Precipitation Forecast (Categorical)

Code Figure	
0	Reserved
1	Drizzle
2	Continuous
3	Showers
4-6	Reserved
7	Missing

where in each case the corresponding code figure from the table would be reported in order to indicate the category which describes the "best guess" forecast for the parameter in question. We certainly could define and request new internationally-coordinated code tables for each specific parameter for which we currently plan to issue a categorical forecast; however, such an approach seems ill-advised since (1) it may be necessary to change threshold values for certain categories in the future (2) other organizations might well wish to make use of such a methodology in the future but almost certainly would want to use different threshold values. Instead, it might be more sensible to adopt a generic approach such as was discussed within the above discourse on probability. For example, perhaps we could invent a new descriptor (perhaps a new Table C operator?) which would signify that the values corresponding to the following descriptors are "best guess" categorical forecast values for the meteorological parameters represented by those descriptors. That way, we could utilize the same methodology for representing ranges, prescribing units, defining time intervals, etc. as was proposed for probability! For example, the descriptor sequence:

2-??-000 "the values corresponding to the following descriptors represent categorical forecast values for the descriptors in question"
0-xx-yyy with corresponding code figure for ">="
0-xx-yyy with corresponding code figure for "<"
0-13-012 with corresponding value of .04
0-13-012 with corresponding value of .09
0-20-003 with corresponding value 180
2-??-255 "turn off" the reporting of categorical forecast values

would indicate that the categorical forecast for fresh snow amount is >= .04 m and < .09 m and that the categorical forecast for present weather is "showers".

ANNEX TO PARAGRAPH 4.1

Modifications to SYNOP FM 12 for reporting precipitation and its global harmonisation

Group 6RRRt_R

Change regulation 12.2.5.4 from:

> "This group shall be omitted from the report:
> (a) When no precipitation occurred during the reference period;
> (b) When precipitation amount was not measured and data are not available.
> The indicator i_R shall indicate which one of these conditions applies."

To:

> "This group shall be:
> (a) Coded with "RRR" = "000", (3 zeros) when precipitation is measured but no precipitation occurred during the reference period;
> (b) Coded with "RRR" = "///", (3 solidi) when precipitation is normally measured but, is not available for the current report;
> (c) Omitted when precipitation is not normally measured. In this case, i_R should be coded as 4.
> (d) Existing Automated Weather Stations (AWS) may continue to report no precipitation with i_R coded as 3 and the 6RRRt_R group omitted. New systems and human observer should report the 6RRRt_R group with "RRR" = "000", (3 zeros) to indicate no precipitation occurred during the reference period.

Under 12.4 Section 3, change regulation 12.4.1 to say:

> "The inclusion of groups with indicator figures 1 up to 6, and 8 and 9 shall be decided regionally. However group 7$R_{24}R_{24}R_{24}R_{24}$ shall be included by all stations capable of doing so, once a day at one appropriate time of the main standard times (00, 06, 12 or 18 UTC)."

(In template for BUFR/CREX of traditional SYNOP, add one descriptor:

> *0 13 023 Total precipitation past 24 hours)*

ANNEX TO PARAGRAPH 5.9

Web-based References for XML

http://www.w3.org/XML/1999/XML-in-10-points

http://www-106.ibm.com/developerworks/xml/library/xml-web/index.html?dwzone=xml

http://www.research.ibm.com/resources/magazine/1999/number_1/xml199.html

http://www.xml.org/

http://www.xml.com/pub/a/98/10/guide0.html

http://www.xml.com/axml/testaxml.htm

http://www.weatherml.com/home.htm

http://zowie.metnet.navy

ANNEX TO PARAGRAPH 7.2.2.3

1. Add a note to Category 01 of BUFR Table D and renumber current note of it as follows.

Notes:

(1) As supplied by originating sub-centre ARINC, this value is a pseudo value rather than the actual value. The relationship between this pseudo value and the true value is known only by ARINC.

(2) Descriptors from 3 01 041 to 3 01 049, and 3 01 062, 3 01 071, and 3 01 072 should not be used in CREX for transmission.

2. Add a note to Category 03 of BUFR Table D as follows.

Note: Descriptors from 3 03 021 to 3 03 027 are not available in CREX.

3. Add a table of Category 05 to BUFR Table D as follows.

Category 05 - Meteorological or hydrological sequences common to hydrological observations

TABLE REFERENCE			TABLE REFERENCES			ELEMENT NAME
F	X	Y				
						(SADC-HYCOS measurement array definition)
3	05	003	3	01	012	Hour, minute of first single measurement minus increment
			0	04	065	Short time increment - time interval between measuremens
			1	01	000	Delayed replication of 1 descriptor
			0	31	001	Replication factor
			3	05	001	Single measurement
						(MEDHYCOS measurement)
3	05	006	0	13	072	Downstream water level
			0	13	082	Water temperature
			0	13	019	Precipitation last hour
			0	12	001	Air temperature
			0	13	073	Maximum water height observed
			0	13	060	Total accumulated precipitation
						(MEDHYCOS report)
3	05	007	3	01	029	Identification
			3	01	012	Hour, minute (time of first measurement)
			0	04	065	Short time increment - time interval between measurements
			1	01	000	Delayed replication of 1 descriptor
			0	31	001	Replication factor
			3	05	006	Single measurement
						(AOCHYCOS - Chad measurement)
3	05	008	3	05	006	Same as MEDHYCOS type measurement
			0	12	030	Soil temperature at -50 cm
						(AOCHYCOS-Chad report)
3	05	009	3	01	029	Identification
			3	01	012	Hour, minute (time of first measurement)
			0	04	065	Short time increment - time interval between measurements

			1	01	000	Delayed replication of 1 descriptor
			0	31	001	Replication factor
			3	05	008	Single measurement
						(MEDHYCOS report type 2)
3	05	011	3	01	029	Identification
			3	01	012	Hour, minute (time of first measurement)
			0	04	065	Short time increment - time interval between measurements
			1	01	000	Delayed replication of 1 descriptor
			0	31	001	Replication factor
			3	05	010	Single measurement
						(MEDHYCOS report with meteorology and water quality data)
3	05	018	3	01	029	Identification
			3	01	012	Hour, minute (time) of first measurement
			0	04	065	Hour increment
			1	03	000	Delayed replications of 3 descriptors
			0	31	001	Replication factor
			3	05	008	Same as AOCHYCOS type measurement
			3	05	016	Meteorological parameters associated to hydrological data
			3	05	017	Water quality measurement

4. In Category 09 of BUFR Table D, add following entry.

						(Ozone sonde flight data)
3	09	030	0	15	004	Ozone sounding correction factor
			0	15	005	Ozone p
			1	04	000	Delayed replication of 4 descriptors
			0	31	001	Replication factor
			0	04	015	Time increment since launch time, if needed; in minutes
			0	08	006	Ozone vertical sounding significance
			0	07	004	Pressure
			0	15	003	Measured ozone partial pressure

5. In Category 16 of BUFR Table D, add following entries.

						(Forecast data)
3	16	022	0	01	032	Generating application (NWP model name, etc. code table defined by originating/generating centre)
			0	02	041	Method for estimating reports related to synoptic feature
			0	19	001	Type of synoptic feature
			0	19	010	Method for tracing of the centre of synoptic feature
			1	18	000	Delayed replication of 18 descriptors
			0	31	001	Replication factor
			0	08	021	Time significance (forecast)
			0	04	014	Time increment (hour)
			0	08	005	Surface synoptic feature significance
			3	01	023	Latitude (coarse accuracy), longitude (coarse accuracy)
			0	19	005	Direction of motion of feature
			0	19	006	Speed of motion of feature
			0	10	004	Pressure
			0	11	041	Maximum wind speed (gust: e.g. used in US)
			0	08	021	Time significance (forecast time averaged)
			0	04	075	Time period (minutes)
			0	11	040	Maximum wind speed (mean wind)
			0	19	008	Vertical extent of feature
			1	05	004	Replicate 5 descriptors 4 times
			0	05	021	Starting bearing or azimuth

	0	05	021	Ending bearing or azimuth
	1	02	002	Replicate 2 descriptors 2 times
	0	19	003	Wind speed threshold
	0	19	004	Effective radius with respect to wind speed above threshold

6. In a paragraph of "CREX tables" of "CREX TABLES, CODE TABLES, FLAG TABLES AND TEMPLATE EXAMPLES" (page I.2-Co LIS-7), modify

"Table D common sequences shall not be defined in both CREX Table D and BUFR Table D" to

"Table D common sequences shall not be defined in both CREX Table D and BUFR Table D unless otherwise a conversion between both Tables D is not simple, that is, the conversion does not completed by replacement of part "F" of each descriptor."

7. Add a table of Category 00 to CREX Table D.

Category 00 -CREX table entries sequences

SEQUENCE			TABLE REFERENCES			ELEMENT NAME
			F	X	Y	
D	00	010	D	00	003	Table D descriptor to be defined
			R	01	000	Delayed replication of 1 descriptor
			B	00	030	Descriptor defining sequence

8. Add a table of Category 02 to CREX Table D.

Category 02 - Meteorological sequences common to surface data

SEQUENCE			TABLE REFERENCES			ELEMENT NAME
			F	X	Y	
D	02	013	D	02	006	Pressure and pressure change
			D	02	003	Wind, temperature, humidity, visibility, weather
			R	01	000	Delayed replication of 1 descriptor
			D	02	005	Cloud layer information

9. In Category 06 of CREX Table D, add following entries.

D	06	001	B	02	032	Indicator for digitization
			R	02	000	Delayed replication of 2 descriptors
			B	07	062	Depth below sea surface
			B	22	042	Subsurface sea temperature
D	06	004	B	02	032	Indicator for digitization
			B	02	033	Method of salinity/depth measurement
			R	03	000	Delayed replication of 3 descriptors
			B	07	062	Depth below sea surface
			B	22	043	Subsurface sea temperature
			B	22	062	Salinity
D	06	005	B	02	031	Method of current measurement
			R	03	000	Delayed replication of 3 descriptors
			B	07	062	Depth below sea surface
			B	22	004	Direction of current

			B	22	031	Speed of current	

10. In Category 07 of CREX Table D, add following entries.

						(Low altitude station)	
D	07	003	D	07	001	Location (high accuracy) and basic report	
			R	01	000	Delayed replication of 1 descriptor	
			D	02	005	Cloud layer information	
						(Low altitude station)	
D	07	004	D	07	002	Location (coarse accuracy) and basic report	
			R	01	000	Delayed replication of 1 descriptor	
			D	02	005	Cloud layer information	
						(D_VVVVV)	
D	07	012	R	03	000	Delayed replication of 3 descriptors (up to 3)	
			B	08	023	First order statistics	
			B	05	021	Direction of visibility observed	D_V
			B	20	001	Horizontal visibility	VVVV
						($D_RD_RV_RV_RV_RV_R$)	
D	07	013	R	06	000	Delayed replication of 6 descriptors (up to 4)	
			B	01	064	Runway designator	D_RD_R
			B	08	014	Qualification for runway visual range	
			B	20	061	Runway visual range	$V_RV_RV_RV_R$
			B	08	014	Qualification for runway visual range	
			B	20	061	Runway visual range	$V_RV_RV_RV_R$
			B	20	018	Tendency of runway visual range	i
						(w´w´)	
D	07	014	R	01	000	Delayed replication of 1 descriptor (up to 3)	
			B	20	019	Significant present weather	w´w´
						(Clouds group(s))	
D	07	015	R	01	000	Delayed replication of 1 descriptor	
			D	02	005	($N_sN_sN_s$, CC, $h_sh_sh_s$)	
			B	20	002	Vertical visibility	VV$h_sh_sh_s$
						(REw´w´)	
D	07	016	R	01	000	Delayed replication of 1 descriptor (up to 3)	
			B	20	020	Significant recent weather phenomena	REw´w´
						(Wind shear on runway(s))	
D	07	017	R	01	000	Delayed replication of 1 descriptor	
			B	11	070	Runway designator of the runway affected by wind shear (including ALL)	WS RWYD_RD_R
						(Trend-type landing forecast)	
D	07	018	B	08	016	Change qualifier of a trend-type forecast or an aerodrome forecast	TTTTT
			R	02	000	Delayed replication of 2 descriptors (up to 2)	
			B	08	017	Qualifier of the time when the forecast change is expected (FM, TL, AT)	TT
			D	01	012	GG, gg	
			R	04	000	Delayed replication of 4 descriptor (up to 1)	
			B	07	006	Height above station	
			B	11	001	Wind direction	ddd
			B	11	002	Wind speed	ff

			B	11	041	Maximum wind speed (gusts)	$f_m f_m$
			B	20	009	General Weather Indicator	
			R	01	000	Delayed replication of 1 descriptor (up to 1)	
			B	20	001	Horizontal visibility	VVVV
			D	07	014	w´w´	

11. In Category 09 of CREX Table D, add following entries.

						(Vertical wind profile)
D	09	001	D	01	037	Identification, etc. (land station, high accuracy position)
			R	01	000	Delayed replication of 1 descriptor
			D	03	011	Winds at heights
						(Vertical wind profile)
D	09	002	D	01	038	Identification, etc. (land station, coarse accuracy position)
			R	01	000	Delayed replication of 1 descriptor
			D	03	011	Winds at heights
						(Vertical wind profile)
D	09	003	D	01	037	Identification, etc. (land station, high accuracy position)
			R	01	000	Delayed replication of 1 descriptor
			D	03	012	Winds at pressure levels
						(Vertical wind profile)
D	09	004	D	01	038	Identification, etc. (land station, coarse accuracy position)
			R	01	000	Delayed replication of 1 descriptor
			D	03	012	Winds at pressure levels
						(Vertical sounding with relative humidity)
D	09	005	D	01	037	Identification, etc. (land station, high accuracy position)
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	013	Pressure, geopotential, temperature and wind data
						(Vertical sounding with relative humidity)
D	09	006	D	01	038	Identification, etc. (land station, coarse accuracy position)
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	013	Pressure, geopotential, temperature and wind data
						(Vertical sounding with dew-point data)
D	09	007	D	01	037	Identification, etc. (land station, high accuracy position)
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	014	Pressure, geopotential, temperature and wind data
						(Vertical sounding with dew-point data)
D	09	008	D	01	038	Identification, etc. (land station, coarse accuracy position)
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	014	Pressure, geopotential, temperature and wind data
						(Vertical wind profile)
D	09	011	D	01	039	Ship's identification, etc.
			R	01	000	Delayed replication of 1 descriptor
			D	03	011	Winds at heights
						(Vertical wind profile)
D	09	012	D	01	039	Ship's identification, etc.

			R	01	000	Delayed replication of 1 descriptor
			D	03	012	Winds at pressure levels
						(Vertical sounding with relative humidity)
D	09	013	D	01	039	Ship's identification, etc.
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	013	Pressure, geopotential, temperature and wind data
						(Vertical sounding with dew-point data)
D	09	014	D	01	039	Ship's identification, etc.
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	014	Pressure, geopotential, temperature and wind data
						(Vertical wind profile)
D	09	015	D	01	040	Ship's identification, etc.
			R	01	000	Delayed replication of 1 descriptor
			D	03	011	Winds at heights
						(Vertical wind profile)
D	09	016	D	01	040	Ship's identification, etc.
			R	01	000	Delayed replication of 1 descriptor
			D	03	012	Winds at pressure levels
						(Vertical sounding with relative humidity)
D	09	017	D	01	040	Ship's identification, etc.
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	013	Pressure, geopotential, temperature and wind data
						(Vertical sounding with dew-point data)
D	09	018	D	01	040	Ship's identification, etc.
			D	02	004	Significant cloud information
			R	01	000	Delayed replication of 1 descriptor
			D	03	014	Pressure, geopotential, temperature and wind data
						(Wind profiler — wind data sounding)
D	09	019	D	01	031	Identification, etc.
			B	02	003	Type of measuring equipment used
			R	01	000	Delayed replication of 1 descriptor
			D	03	011	Winds at heights
						(Wind profiler — Cartesian coordinates)
D	09	020	D	01	031	Identification, etc.
			B	02	003	Type of measuring equipment used
			R	04	000	Delayed replication of 4 descriptors
			B	07	003	Geopotential
			B	11	003	u-component
			B	11	004	v-component
			B	11	005	w-component

12. Add a table of Category 11 to CREX Table D.

Category 11 - Single level report sequences (conventional data)

SEQUENCE	TABLE REFERENCES	ELEMENT NAME

			F	X	Y	
						(ACARS supplementary reported variables)
D	11	004	R	01	000	Delayed replication of 1 descriptor
			B	11	034	Vertical gust velocity
			R	01	000	Delayed replication of 1 descriptor
			B	11	035	Vertical gust acceleration
			R	01	000	Delayed replication of 1 descriptor
			B	11	075	Mean turbulence intensity (eddy dissipation rate)
			R	01	000	Delayed replication of 1 descriptor
			B	11	076	Peak turbulence intensity (eddy dissipation rate)
			R	01	000	Delayed replication of 1 descriptor
			B	33	025	ACARS interpolated values
			R	01	000	Delayed replication of 1 descriptor
			B	33	026	Mixing ratio quality

13. In Category 16 of CREX Table D, add following entries.

						(Jet stream)
D	16	003	R	09	000	Delayed replication of 9 descriptors
			B	08	011	Meteorological feature (jet stream value)
			B	08	007	Dimensional significance (value for line)
			R	04	000	Delayed replication of 4 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	10	002	Flight level (altitude)
			B	11	002	Wind speed
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Turbulence)
D	16	004	R	10	000	Delayed replication of 10 descriptors
			B	08	011	Meteorological feature (value for turbulence)
			B	08	007	Dimensional significance (value for area)
			B	07	002	Flight level (altitude) (base of layer)
			B	07	002	Flight level (altitude) (top of layer)
			R	02	000	Delayed replication of 2 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	11	031	Degree of turbulence
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Storm)
D	16	005	R	08	000	Delayed replication of 8 descriptors
			B	08	005	Meteorological attribute significance (storm centre)
			B	08	007	Dimensional significance (value for point)
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	01	026	WMO storm name (use “UNKNOWN” for a sandstorm)
			B	19	001	Synoptic features (value for type of storm)
			B	08	007	Dimensional significance (cancel)
			B	08	005	Meteorological attribute significance (cancel/end of object)
						(Cloud)
D	16	006	R	11	000	Delayed replication of 11 descriptors
			B	08	011	Meteorological feature (value for cloud)
			B	08	007	Dimensional significance (value for area)
			B	07	002	Flight level (altitude) (base of layer)
			B	07	002	Flight level (altitude) (top of layer)

			R	02	000	Delayed replication of 2 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	20	011	Cloud amount
			B	20	012	Cloud type
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Front)
D	16	007	R	09	000	Delayed replication of 9 descriptors
			B	08	011	Meteorological feature (value for type of front)
			B	08	007	Dimensional significance (value for line)
			R	04	000	Delayed replication of 4 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	19	005	Direction of feature
			B	19	006	Speed of feature
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Tropopause)
D	16	008	R	10	000	Delayed replication of 10 descriptors
			B	08	001	Vertical significance (bit 3 set for tropopause)
			B	08	007	Dimensional significance (value for point)
			B	08	023	Statistic (type of tropopause value)
			R	03	000	Delayed replication of 3 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	10	002	Height/altitude
			B	08	023	Statistic (cancel)
			B	08	007	Dimensional significance (cancel)
			B	08	001	Vertical significance (cancel/end of object)
						(Airframe icing area)
D	16	009	R	10	000	Delayed replication of 10 descriptors
			B	08	011	Meteorological feature (value for airframe icing)
			B	08	007	Dimensional significance (value for area)
			B	07	002	Flight level (altitude) (base of layer)
			B	07	002	Flight level (altitude) (top of layer)
			R	02	000	Delayed replication of 2 descriptors
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	20	041	Airframe icing (type of airframe icing)
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Name of feature)
D	16	010	R	07	000	Delayed replication of 7 descriptors
			B	08	011	Meteorological feature
			B	08	007	Dimensional significance (value for point)
			B	01	022	Name of feature
			B	05	002	Latitude (coarse)
			B	06	002	Longitude (coarse)
			B	08	007	Dimensional significance (cancel)
			B	08	011	Meteorological feature (cancel/end of object)
						(Volcano erupting)
D	16	011	R	16	000	Delayed replication of 16 descriptors
			B	08	011	Meteorological feature (value for special clouds)

B	01	022	Name of feature (volcano name)
B	08	007	Dimensional significance (value for point)
R	02	000	Delayed replication of 2 descriptors
B	05	002	Latitude (coarse)
B	06	002	Longitude (coarse)
B	08	021	Time significance (eruption starting time)
B	04	001	Year
B	04	002	Month
B	04	003	Day
B	04	004	Hour
B	04	005	Minute
B	20	090	Special clouds (clouds from volcanic eruptions)
B	08	021	Time significance (cancel)
B	08	007	Dimensional significance (cancel)
B	08	011	Meteorological feature (cancel/end of object)

Comparison between Tables D of BUFR and CREX related to *ITEM 1*

BUFR Table D

Category 05-*Meteorological or hydrological sequences common to hydrological observations*

TABLE REFERENCE F X Y	TABLE REFERENCE S	ELEMENT NAME
		(SADC-HYCOS measurement array definition)
3 05 003	3 01 012	Hour, minute of first single measurement minus increment
	0 04 065	Short time increment - time interval between measuremens
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 05 001	Single measurement
		(MEDHYCOS measurement)
3 05 006	0 13 072	Downstream water level
	0 13 082	Water temperature
	0 13 019	Precipitation last hour
	0 12 001	Air temperature
	0 13 073	Maximum water height observed
	0 13 060	Total accumulated precipitation
		(MEDHYCOS report)
3 05 007	3 01 029	Identification
	3 01 012	Hour, minute (time of first measurement)
	0 04 065	Short time increment - time interval between measurements
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 05 006	Single measurement
		(AOCHYCOS - Chad measurement)
3 05 008	3 05 006	Same as MEDHYCOS type measurement
	0 12 030	Soil temperature at -50 cm
		(AOCHYCOS-Chad report)
3 05 009	3 01 029	Identification
	3 01 012	Hour, minute (time of first measurement)
	0 04 065	Short time increment - time interval between measurements
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 05 008	Single measurement
		(MEDHYCOS report type 2)
3 05 011	3 01 029	Identification
	3 01 012	Hour, minute (time of first measurement)
	0 04 065	Short time increment - time interval between measurements
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 05 010	Single measurement
		(MEDHYCOS report with meteorology and water quality data)
3 05 018	3 01 029	Identification
	3 01 012	Hour, minute (time) of first measurement
	0 04 065	Hour increment
	1 03 000	Delayed replications of 3 descriptors
	0 31 001	**Replication factor**
	3 05 008	Same as AOCHYCOS type measurement
	3 05 016	Meteorological parameters associated to hydrological data
	3 05 017	Water quality measurement

CREX Table D

Category 05-*Meteorological or hydrological sequences common to hydrological observations*

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(SADC-HYCOS measurement array definition)
D 05 003	D 01 012	Hour, minute of first single measurement minus increment
	B 04 065	Short time increment - time interval between measuremens
	R 01 000	Delayed replication n times of next descriptor
	D 05 001	Single measurement
		(MEDHYCOS measurement)
D 05 006	B 13 072	Downstream water level
	B 13 082	Water temperature
	B 13 019	Precipitation last hour
	C 07 005	**Next datum in Kelvin**
	C 01 004	**Next datum over four characters**
	B 12 001	Air temperature
	B 13 073	Maximum water height observed
	B 13 060	Total accumulated precipitation
		(MEDHYCOS report)
D 05 007	D 01 029	Identification
	D 01 012	Hour, minute (time of first measurement)
	B 04 065	Short time increment - time interval between measurements
	R 01 000	Delayed replication n times of next descriptor
	D 05 006	Single measurement
		(AOCHYCOS - Chad measurement)
D 05 008	D 05 006	Same as MEDHYCOS type measurement
	C 07 005	**Next datum in Kelvin**
	C 01 004	**Next datum over four characters**
	B 12 030	Soil temperature at -50 cm
		(AOCHYCOS-Chad report)
D 05 009	D 01 029	Identification
	D 01 012	Hour, minute (time of first measurement)
	B 04 065	Short time increment - time interval between measurements
	R 01 000	Delayed replication n times of next descriptor
	D 05 008	Single measurement
		(MEDHYCOS report type 2)
D 05 011	D 01 029	Identification
	D 01 012	Hour, minute (time of first measurement)
	B 04 065	Short time increment - time interval between measurements
	R 01 000	Delayed replication n times of next descriptor
	D 05 010	Single measurement
		(MEDHYCOS report with meteorology and water quality
D 05 018	D 01 029	data)
	D 01 012	Identification
	B 04 065	Hour, minute (time) of first measurement
	R 03 000	Hour increment
	D 05 008	Delayed replications n times of next three descriptors
	D 05 016	Same as AOCHYCOS type measurement
	D 05 017	Meteorological parameters associated to hydrological data
		Water quality measurement

Comparison between Tables D of BUFR and CREX related to ***ITEM 2***

BUFR Table D

In Category 09 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Ozone sonde flight data)
3 09 030	0 15 004	Ozone sounding correction factor
	0 15 005	Ozone p
	1 04 000	Delayed replication of 4 descriptors
	0 31 001	**Replication factor**
	0 04 015	Time increment since launch time, if needed; in minutes
	0 08 006	Ozone vertical sounding significance
	0 07 004	Pressure
	0 15 003	Measured ozone partial pressure

CREX Table D

In Category 09 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Ozone sonde flight data)
D 09 030	B 15 004	Ozone sounding correction factor
	B 15 005	Ozone p
	R 04 000	Delayed replication
	B 04 015	Time increment since launch time, if needed; in minutes
	B 08 006	Ozone vertical sounding significance
	B 07 004	Pressure
	B 15 003	Measured ozone partial pressure

Comparison between Tables D of BUFR and CREX related to ***ITEM 3***

BUFR Table D

In Category 16 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Forecast data)
3 16 022	0 01 032	Generating application (NWP model name, etc. code table defined by originating/generating Centre)
	0 02 041	Method for estimating reports related to synoptic features
	0 19 001	Type of synoptic feature
	0 19 010	Method for tracing of the centre of synoptic feature
	1 18 000	Delayed replication of 18 descriptors
	0 31 001	**Replication factor**
	0 08 021	Time significance (forecast)
	0 04 014	Time increment (hour)
	0 08 005	Surface synoptic feature significance
	3 01 023	Latitude (coarse accuracy), longitude (coarse accuracy)
	0 19 005	Direction of motion of feature
	0 19 006	Speed of motion of feature
	0 10 004	Pressure
	0 11 041	Maximum wind speed (gust:s: e.g. used in the US)
	0 08 021	Time significance (forecast time averaged)
	0 04 075	Time period (minutes)
	0 11 040	Maximum wind speed (mean wind)
	0 19 008	Vertical extent of feature
	1 05 004	Replicate 5 descriptors 4 times
	0 05 021	Starting bearing or azimuth
	0 05 021	Ending bearing or azimuth
	1 02 002	Replicate 2 descriptors 2 times
	0 19 003	Wind speed threshold
	0 19 004	Effective radius with respect to wind speed above threshold

CREX Table D

In Category 16 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Forecast data)
D 16 022	B 01 032	Generating application (NWP model name, etc. code table defined by originating/generating Centre)
	B 02 041	Method for estimating reports related to synoptic features
	B 19 001	Type of synoptic feature
	B 19 010	Method for tracing of the centre of synoptic feature
	R 18 000	(NN times replication of following 18 descriptors - delayed replication)
	B 08 021	Time significance (forecast)
	B 04 014	Time increment (hour)
	B 08 005	Surface synoptic feature significance
	D 01 023	Latitude (coarse accuracy), longitude (coarse accuracy)
	B 19 005	Direction of motion of feature
	B 19 006	Speed of motion of feature
	B 10 004	Pressure
	B 11 041	Maximum wind speed (gusts: e.g. used in the US)
	B 08 021	Time significance (forecast time averaged)
	B 04 075	Time period (minutes)
	B 11 040	Maximum wind speed (mean wind)
	B 19 008	Vertical extent of feature
	R 05 004	(Four times replication of following five descriptors)
	B 05 021	Starting bearing or azimuth
	B 05 021	Ending bearing or azimuth
	R 02 002	(Two times replication of following two descriptors)
	B 19 003	Wind speed threshold
	B 19 004	Effective radius with respect to wind speed above threshold

Comparison between Tables D of BUFR and CREX related to ***ITEM 5***

BUFR Table D

Category 00 - *BUFR table entries sequences*

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 00 010	3 00 003 1 01 000 **0 31 001** 0 00 030	Table D descriptor to be defined Delayed replication of 1 descriptor Delayed descriptor replication factor Descriptor defining sequence

CREX Table D

Category 00 - *CREX table entries sequences*

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
D 00 010	D 00 003 R 01 000 B 00 030	Table D descriptor to be defined Delayed replication of 1 descriptor Descriptor defining sequence

Comparison between Tables D of BUFR AND CREX related to ***ITEM 6***

BUFR Table D

In Category 01 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 01 041	0 01 007	Satellite identifier
	0 02 021	Satellite instrument data used in processing
	0 02 022	Satellite data processing technique used
	3 01 011	Date
	3 01 012	Time
3 01 042	3 01 041	Satellite identifier, data used, and data processing technique; date/time
	3 01 021	Latitude, longitude
3 01 043	0 01 007	Satellite identifier
	0 02 023	Cloud motion computational method
	3 01 011	Date
	3 01 013	Time
	3 01 021	Latitude, longitude
3 01 044	0 01 007	Satellite identifier
	0 02 024	Integrated mean humidity computational method
	3 01 011	Date
	3 01 013	Time
	3 01 021	Latitude, longitude
		(Satellite location and velocity)
3 01 045	3 01 011	Year, month, day
	3 01 012	Time (hour, minute)
	2 01 138	Change width to 16 bits
	2 02 131	Change scale to 3
	0 04 006	Second
	2 01 000	Change width back to Table B
	2 02 000	Change scale back to Table B
	3 04 030	Location relative to the Earth's centre
	3 04 031	Velocity relative to the Earth's centre
3 01 046	0 01 007	Satellite identifier
	0 01 012	Direction of motion of moving observing platform
	0 02 048	Satellite sensor indicator
	0 21 119	Wind scatterometer geophysical model function
	0 25 060	Software identification
	2 02 124	Change scale
	0 02 026	Cross-track resolution
	0 02 027	Along-tract resolution
	2 02 000	Change scale back to Table B
	0 05 040	Orbit number

CREX Table D

In Category 01 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
D 01 041		Not to be used in CREX for transmission
D 01 042		Not to be used in CREX for transmission
D 01 043		Not to be used in CREX for transmission
D 01 044		Not to be used in CREX for transmission
D 01 045		Not to be used in CREX for transmission
D 01 046		Not to be used in CREX for transmission
D 01 047		Not to be used in CREX for transmission
D 01 048		Not to be used in CREX for transmission
D 01 049		Not to be used in CREX for transmission
D 01 062		Not to be used in CREX for transmission
D 01 071		Not to be used in CREX for transmission
D 01 072		Not to be used in CREX for transmission

Comparison between Tables D of BUFR AND CREX related to ***ITEM 6*** (continued)

BUFR Table D

In Category 01 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(ERS product header)
3 01 047	0 01 007	Satellite identifier
	0 25 060	Software identification
	0 01 033	Originating/generating centre
	0 01 034	Originating/generating sub-centre
	0 01 012	Direction of motion of moving observation platform
	3 01 045	Satellite location and velocity
	0 02 021	Satellite instrument data used in processing
	3 01 011	Date (year, month, day)
	3 01 012	Time (hour, minute)
	2 01 138	Change bit width to 16 bits
	2 02 131	Change scale to 3
	0 04 006	Second
	2 01 000	Change width back to Table B
	2 02 000	Change scale back to Table B
	3 01 023	Location (latitude, longitude)
		(Radar parameters)
3 01 048	0 02 104	Antenna polarization
	0 02 121	Mean frequency
	0 02 113	Number of azimuth looks
	0 02 026	Cross-track resolution
	0 02 027	Along-track resolution
	0 02 111	Radar incidence angle
	0 02 140	Satellite radar beam azimuth angle
	2 02 127	Change scale to –1
	0 01 013	Radar platform velocity
	2 02 126	Change scale to –2
	0 07 001	Radar platform altitude
	2 02 000	Change scale to Table B
	0 25 010	Clutter treatment
	0 21 064	Clutter noise estimate
		(Radar beam data)
3 01 049	0 02 111	Radar incidence angle
	0 02 112	Radar look angle
	0 21 062	Backscatter
	0 21 063	Radiometric resolution (Noise value)
	0 21 065	Missing packet counter
		(Radar location(s))
3 01 062	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Replication factor
	3 01 001	WMO block and station number

CREX Table D

In Category 01 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME

Comparison between Tables D of BUFR AND CREX related to ***ITEM 6*** (continued)

BUFR Table D

In Category 01 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Satellite identifier/Generating resolution)
3 01 071	0 01 007	Satellite identifier
	0 01 031	Generating centre
	0 02 020	Satellite classification
	0 02 028	Segment size at nadir in X direction
	0 02 029	Segment size at nadir in Y direction
		(Satellite identification)
3 01 072	3 01 071	Satellite identification, Generation resolution
	3 01 011	Date
	3 01 013	Time
	3 01 021	Latitude, longitude

CREX Table D

In Category 01 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME

Comparison between Tables D of BUFR and CREX related to ***ITEM 7*** (No.1)

BUFR Table D

Category 02 - *Meteorological sequences common to surface data*

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 02 013	3 02 006	Pressure and pressure change
	3 02 003	Wind, temperature, humidity, visibility, weather
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Delayed descriptor replication factor**
	3 02 005	Cloud layer information

CREX Table D

Category 02 - *Meteorological sequences common to surface data*

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
D 02 013	D 02 006	Pressure and pressure change
	D 02 003	Wind, temperature, humidity, visibility, weather
	R 01 000	Delayed replication of 1 descriptor
	D 02 005	Cloud layer information

Comparison between Tables D of BUFR AND CREX related to ***ITEM 7*** (No.2)

BUFR Table D

In Category 03 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 03 021	0 07 004	Pressure (1)
	0 07 004	Pressure (2) defines layer
	2 04 007	**Add associated field of 7 bits**
	0 31 021	**Additional field significance**
3 03 022	3 03 021	Layer, quality
	0 10 003	Geopotential (layer mean thickness)
	2 04 000	**Cancel the added associated field**
3 03 023	3 03 021	Layer, quality
	0 12 001	Temperature (layer mean)
	2 04 000	**Cancel the added associated field**
3 03 024	3 03 021	Layer, quality
	0 13 016	Precipitation water
	2 04 000	**Cancel the added associated field**
3 03 025	0 02 025	Satellite channel
	2 04 007	**Add associated field of 7 bits**
	0 31 021	**Additional field significance**
	0 12 063	Brightness temperature
	2 04 000	**Cancel the added associated field**
3 03 026	0 07 004	Pressure
	0 08 003	Vertical significance
	2 04 007	**Add associated field of 7 bits**
	0 31 021	**Additional field significance**
	0 12 001	Temperature
	2 04 000	**Cancel the added associated field**
3 03 027	0 07 004	Pressure
	2 04 007	**Add associated field of 7 bits**
	0 31 021	**Additional field significance**
	0 10 003	Geopotential
	2 04 000	**Cancel the added associated field**

CREX Table D

In Category 03 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
D 03 021		not available
D 03 022		not available
D 03 023		not available
D 03 024		not available
D 03 025		not available
D 03 026		not available
D 03 027		not available

Comparison between Tables D of BUFR and CREX related to ***ITEM 8***

BUFR Table D

In Category 06 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 06 001	0 02 032	Indicator for digitization
	1 02 000	Delayed replication of 2 descriptors
	0 31 001	**Replication factor**
	0 07 062	Depth below sea surface
	0 22 042	Subsurface sea temperature
3 06 004	0 02 032	Indicator for digitization
	0 02 033	Method of salinity/depth measurement
	1 03 000	Delayed replication of 3 descriptors
	0 31 001	**Replication factor**
	0 07 062	Depth below sea surface
	0 22 043	Subsurface sea temperature
	0 22 062	Salinity
3 06 005	0 02 031	Method of current measurement
	1 03 000	Delayed replication of 3 descriptors
	0 31 001	**Replication factor**
	0 07 062	Depth below sea surface
	0 22 004	Direction of current
	0 22 031	Speed of current

CREX Table D

In Category 06 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
D 06 001	B 02 032	Indicator for digitization
	R 02 000	Delayed replication of 2 descriptors
	B 07 062	Depth below sea surface
	B 22 042	Subsurface sea temperature
D 06 004	B 02 032	Indicator for digitization
	B 02 033	Method of salinity/depth measurement
	R 03 000	Delayed replication of 3 descriptors
	B 07 062	Depth below sea surface
	B 22 043	Subsurface sea temperature
	B 22 062	Salinity
D 06 005	B 02 031	Method of current measurement
	R 03 000	Delayed replication of 3 descriptors
	B 07 062	Depth below sea surface
	B 22 004	Direction of current
	B 22 031	Speed of current

Comparison between Tables D of BUFR and CREX related to ***ITEM 9***

BUFR Table D

In Category 07 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME	
		(Low altitude station)	
3 07 003	3 07 001	Location (high accuracy) and basic	
	1 01 000	report	
	0 31 001	Delayed replication of 1 descriptor	
	3 02 005	**Replication factor**	
		Cloud layer information	
3 07 004	3 07 002	(Low altitude station)	
	1 01 000	Location (coarse accuracy) and basic	
	0 31 001	report	
	3 02 005	Delayed replication of 1 descriptor	
		Replication factor	
3 07 012	1 03 000	Cloud layer information	
	0 31 001	(D_VVVVV)	
	0 08 023	Delayed replication of 3 descriptors	
	0 05 021	**Number of replication (up to 3)**	D_V
	0 20 001	First order statistics	VVVV
		Direction of visibility observed	
3 07 013	1 06 000	Horizontal visibility	
	0 31 001	($D_RD_RV_RV_RV_RV_R$)	
	0 01 064	Delayed replication of 6 descriptors	D_RD_R
	0 08 014	**Number of replication (up to 4)**	
	0 20 061	Runway designator	$V_RV_RV_RV_R$
	0 08 014	Qualification for runway visual range	
	0 20 061	Runway visual range	$V_RV_RV_RV_R$
	0 20 018	Qualification for runway visual range	i
		Runway visual range	
3 07 014	1 01 000	Tendency of runway visual range	
	0 31 001	(w´w´)	
	0 20 019	Delayed replication of 1 descriptor	w´w´
		Number of replication (up to 3)	
3 07 015	1 01 000	Significant present weather	
	0 31 001	(Clouds group(s))	
	3 02 005	Delayed replication of 1 descriptor	
	0 20 002	**Number of replication**	VV$h_Sh_Sh_S$
		($N_sN_sN_s$, CC, $h_sh_sh_s$)	
3 07 016	1 01 000	Vertical visibility	
	0 31 001	(REw´w´)	
	0 20 020	Delayed replication of 1 descriptor	REw´w´
		Number of replication (up to 3)	
3 07 017	1 01 000	Significant recent weather phenomena	
	0 31 001	(Wind shear on runway(s))	
	0 11 070	Delayed replication of 1 descriptor	WS RWYD_RD_R
		Number of replication	
		Runway designator of the runway	
		affected	
		by wind shear (including ALL)	

CREX Table D

In Category 07 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME	
		(Low altitude station)	
D 07 003	D 07 001	Location (high accuracy) and basic	
	R 01 000	report	
	D 02 005	Delayed replication of 1 descriptor	
		Cloud layer information	
D 07 004	D 07 002	(Low altitude station)	
	R 01 000	Location (coarse accuracy) and basic	
	D 02 005	report	
		Delayed replication of 1 descriptor	
		Cloud layer information	
D 07 012	R 03 000		
	B 08 023	(D_VVVVV)	
	B 05 021	Delayed replication of 3 descriptors (up	D_V
	B 20 001	to 3)	VVVV
		First order statistics	
		Direction of visibility observed	
D 07 013	R 06 000	Horizontal visibility	
	B 01 064		D_RD_R
	B 08 014	($D_RD_RV_RV_RV_RV_R$)	
	B 20 061	Delayed replication of 6 descriptors (up	$V_RV_RV_RV_R$
	B 08 014	to 4)	
	B 20 061	Runway designator	$V_RV_RV_RV_R$
	B 20 018	Qualification for runway visual range	i
		Runway visual range	
		Qualification for runway visual range	
D 07 014	R 01 000	Runway visual range	
	B 20 019	Tendency of runway visual range	w´w´
		(w´w´)	
D 07 015	R 01 000	Delayed replication of 1 descriptor (up to	
	D 02 005	3)	
	B 20 002	Significant present weather	VV$h_Sh_Sh_S$
		(Clouds group(s))	
D 07 016	R 01 000	Delayed replication of 1 descriptor	
	B 20 020	($N_sN_sN_s$, CC, $h_sh_sh_s$)	REw´w´
		Vertical visibility	
D 07 017	R 01 000	(REw´w´)	
	B 11 070	Delayed replication of 1 descriptor (up to	WS
		3)	RWYD_RD_R
		Significant recent weather phenomena	
		(Wind shear on runway(s))	
		Delayed replication of 1 descriptor	
		Runway designator of the runway	
		affected	
		by wind shear (including ALL)	

Comparison between Tables D of BUFR and CREX related to ***ITEM 9*** (continued)

BUFR Table D

In Category 07 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME	
		(Trend-type landing forecast)	
3 07 018	0 08 016	Change qualifier of a trend-type forecast or an aerodrome forecast	TTTTT
	1 02 000	Delayed replication of 2 descriptors	
	0 31 001	**Number of replication (up to 2)**	
	0 08 017	Qualifier of the time when the forecast change is expected (FM, TL, AT)	TT
	3 01 012	GG, gg	
	1 04 000	Delayed replication of 4 descriptor	
	0 31 001	**Number of replication (up to 1)**	
	0 07 006	Height above station	
	0 11 001	Wind direction	ddd
	0 11 002	Wind speed	ff
	0 11 041	Maximum wind speed (gusts)	$f_m f_m$
	0 20 009	General Weather Indicator	
	1 01 000	Delayed replication of 1 descriptor	
	0 31 001	**Number of replication (up to 1)**	
	0 20 001	Horizontal visibility	VVVV
	3 07 014	w´w´	

CREX Table D

In Category 07 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME	
		(Trend-type landing forecast)	
D 07 018	B 08 016	Change qualifier of a trend-type forecast or an aerodrome forecast	TTTTT
	R 02 000	Delayed replication of 2 descriptors (up to 2)	
	B 08 017	Qualifier of the time when the forecast change is expected (FM, TL, AT)	TT
	D 01 012	GG, gg	
	R 04 000	Delayed replication of 4 descriptor (up to 1)	
	B 07 006	Height above station	ddd
	B 11 001	Wind direction	ff
	B 11 002	Wind speed	$f_m f_m$
	B 11 041	Maximum wind speed (gusts)	
	B 20 009	General Weather Indicator	
	R 01 000	Delayed replication of 1 descriptor (up to 1)	VVVV
	B 20 001	Horizontal visibility	
	D 07 014	w´w´	

Comparison between Tables D of BUFR and CREX related to ***ITEM 10***

BUFR Table D

In Category 09 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Vertical wind profile)
3 09 001	3 01 037	Identification, etc. (land station, high accuracy position)
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 011	Winds at heights
		(Vertical wind profile)
3 09 002	3 01 038	Identification, etc. (land station, coarse accuracy position)
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 011	Winds at heights
		(Vertical wind profile)
3 09 003	3 01 037	Identification, etc. (land station, high accuracy position)
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 012	Winds at pressure levels
		(Vertical wind profile)
3 09 004	3 01 038	Identification, etc. (land station, coarse accuracy position)
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 012	Winds at pressure levels
		(Vertical sounding with relative humidity)
3 09 005	3 01 037	Identification, etc. (land station, high accuracy position)
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with relative humidity)
3 09 006	3 01 038	Identification, etc. (land station, coarse accuracy position)
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
3 09 007	3 01 037	Identification, etc. (land station, high accuracy position)
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 014	Pressure, geopotential, temperature and wind data

CREX Table D

In Category 09 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Vertical wind profile)
D 09 001	D 01 037	Identification, etc. (land station, high accuracy position)
	R 01 000	Delayed replication of 1 descriptor
	D 03 011	Winds at heights
		(Vertical wind profile)
D 09 002	D 01 038	Identification, etc. (land station, coarse accuracy position)
	R 01 000	Delayed replication of 1 descriptor
	D 03 011	Winds at heights
		(Vertical wind profile)
D 09 003	D 01 037	Identification, etc. (land station, high accuracy position)
	R 01 000	Delayed replication of 1 descriptor
	D 03 012	Winds at pressure levels
		(Vertical wind profile)
D 09 004	D 01 038	Identification, etc. (land station, coarse accuracy position)
	R 01 000	Delayed replication of 1 descriptor
	D 03 012	Winds at pressure levels
		(Vertical sounding with relative humidity)
D 09 005	D 01 037	Identification, etc. (land station, high accuracy position)
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with relative humidity)
D 09 006	D 01 038	Identification, etc. (land station, coarse accuracy position)
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
D 09 007	D 01 037	Identification, etc. (land station, high accuracy position)
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 014	Pressure, geopotential, temperature and wind data

Comparison between Tables D of BUFR and CREX related to ***ITEM 10*** (continued)

BUFR Table D

In Category 09 of BUFR Table D

TABLE REFERENCE	TABLE REFERENCES	ELEMENT NAME
F X Y		
		(Vertical sounding with dew-point data)
3 09 008	3 01 038	Identification, etc. (land station, coarse accuracy position)
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 014	Pressure, geopotential, temperature and wind data
		(Vertical wind profile)
3 09 011	3 01 039	Ship's identification, etc.
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 011	Winds at heights
		(Vertical wind profile)
3 09 012	3 01 039	Ship's identification, etc.
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 012	Winds at pressure levels
		(Vertical sounding with relative humidity)
3 09 013	3 01 039	Ship's identification, etc.
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
3 09 014	3 01 039	Ship's identification, etc.
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 014	Pressure, geopotential, temperature and wind data
		(Vertical wind profile)
3 09 015	3 01 040	Ship's identification, etc.
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 011	Winds at heights
		(Vertical wind profile)
3 09 016	3 01 040	Ship's identification, etc.
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 012	Winds at pressure levels

CREX Table D

In Category 09 of CREX Table D

SEQUENCE	TABLE REFERENCES	ELEMENT NAME
	F X Y	
		(Vertical sounding with dew-point data)
D 09 008	D 01 038	Identification, etc. (land station, coarse accuracy position)
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 014	Pressure, geopotential, temperature and wind data
		(Vertical wind profile)
D 09 011	D 01 039	Ship's identification, etc.
	R 01 000	Delayed replication of 1 descriptor
	D 03 011	Winds at heights
		(Vertical wind profile)
D 09 012	D 01 039	Ship's identification, etc.
	R 01 000	Delayed replication of 1 descriptor
	D 03 012	Winds at pressure levels
		(Vertical sounding with relative humidity)
D 09 013	D 01 039	Ship's identification, etc.
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
D 09 014	D 01 039	Ship's identification, etc.
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 014	Pressure, geopotential, temperature and wind data
		(Vertical wind profile)
D 09 015	D 01 040	Ship's identification, etc.
	R 01 000	Delayed replication of 1 descriptor
	D 03 011	Winds at heights
		(Vertical wind profile)
D 09 016	D 01 040	Ship's identification, etc.
	R 01 000	Delayed replication of 1 descriptor
	D 03 012	Winds at pressure levels

Comparison between Tables D of BUFR and CREX related to ***ITEM 10*** (continued)

BUFR Table D

In Category 09 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Vertical sounding with relative humidity)
3 09 017	3 01 040	Ship's identification, etc.
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
3 09 018	3 01 040	Ship's identification, etc.
	3 02 004	Significant cloud information
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 014	Pressure, geopotential, temperature and wind data
		(Wind profiler - wind data sounding)
3 09 019	3 01 031	Identification, etc.
	0 02 003	Type of measuring equipment used
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	**Replication factor**
	3 03 011	Winds at heights
		(Wind profiler - Cartesian coordinates)
3 09 020	3 01 031	Identification, etc.
	0 02 003	Type of measuring equipment used
	1 04 000	Delayed replication of 4 descriptors
	0 31 001	**Replication factor**
	0 07 003	Geopotential
	0 11 003	u-component
	0 11 004	v-component
	0 11 005	w-component

CREX Table D

In Category 09 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Vertical sounding with relative humidity)
D 09 017	D 01 040	Ship's identification, etc.
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 013	Pressure, geopotential, temperature and wind data
		(Vertical sounding with dew-point data)
D 09 018	D 01 040	Ship's identification, etc.
	D 02 004	Significant cloud information
	R 01 000	Delayed replication of 1 descriptor
	D 03 014	Pressure, geopotential, temperature and wind data
		(Wind profiler - wind data sounding)
D 09 019	D 01 031	Identification, etc.
	B 02 003	Type of measuring equipment used
	R 01 000	Delayed replication of 1 descriptor
	D 03 011	Winds at heights
		(Wind profiler - Cartesian coordinates)
D 09 020	D 01 031	Identification, etc.
	B 02 003	Type of measuring equipment used
	R 04 000	Delayed replication of 4 descriptors
	B 07 003	Geopotential
	B 11 003	u-component
	B 11 004	v-component
	B 11 005	w-component

Comparison between Tables D of BUFR and CREX related to ***ITEM 11***

BUFR Table D

Category 11 - *Single level report sequences (conventional data)*

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(ACARS supplementary reported variables)
3 11 004	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 11 034	Vertical gust velocity
	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 11 035	Vertical gust acceleration
	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 11 075	Mean turbulence intensity (eddy dissipation rate)
	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 11 076	Peak turbulence intensity (eddy dissipation rate)
	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 33 025	ACARS interpolated values
	1 01 000	Delayed replication of one descriptor
	0 31 000	**Short delayed descriptor replication factor**
	0 33 026	Mixing ratio quality

CREX Table D

Category 11 - *Single level report sequences (conventional data)*

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(ACARS supplementary reported variables)
D 11 004	R 01 000	Delayed replication of 1 descriptor
	B 11 034	Vertical gust velocity
	R 01 000	Delayed replication of 1 descriptor
	B 11 035	Vertical gust acceleration
	R 01 000	Delayed replication of 1 descriptor
	B 11 075	Mean turbulence intensity (eddy dissipation rate)
	R 01 000	Delayed replication of 1 descriptor
	B 11 076	Peak turbulence intensity (eddy dissipation rate)
	R 01 000	Delayed replication of 1 descriptor
	B 33 025	ACARS interpolated values
	R 01 000	Delayed replication of 1 descriptor
	B 33 026	Mixing ratio quality

Comparison between Tables D of BUFR and CREX related to ***ITEM 12***

BUFR Table D

In Category 16 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Jet stream)
3 16 003	**1 10 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 011	Meteorological feature (jet stream value)
	0 08 007	Dimensional significance (value for line)
	1 04 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 10 002	Flight level (altitude)
	0 11 002	Wind speed
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Turbulence)
3 16 004	**1 11 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 011	Meteorological feature (value for turbulence)
	0 08 007	Dimensional significance (value for area)
	0 07 002	Flight level (altitude) (base of layer)
	0 07 002	Flight level (altitude) (top of layer)
	1 02 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 11 031	Degree of turbulence
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Storm)
3 16 005	1 08 000	Delayed replication
	0 31 001	**Replication**
	0 08 005	Meteorological attribute significance (storm centre)
	0 08 007	Dimensional significance (value for point)
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 01 026	WMO storm name (use “UNKNOWN” for a sandstorm)
	0 19 001	Synoptic features (value for type of storm)
	0 08 007	Dimensional significance (cancel)
	0 08 005	Meteorological attribute significance (cancel/end of object)

CREX Table D

In Category 16 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Jet stream)
D 16 003	**R 09 000**	**Delayed replication of 9 descriptors**
	B 08 011	Meteorological feature (jet stream value)
	B 08 007	Dimensional significance (value for line)
	R 04 000	Delayed replication of 4 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 10 002	Flight level (altitude)
	B 11 002	Wind speed
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Turbulence)
D 16 004	**R 10 000**	**Delayed replication of 10 descriptors**
	B 08 011	Meteorological feature (value for turbulence)
	B 08 007	Dimensional significance (value for area)
	B 07 002	Flight level (altitude) (base of layer)
	B 07 002	Flight level (altitude) (top of layer)
	R 02 000	Delayed replication of 2 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 11 031	Degree of turbulence
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Storm)
D 16 005	R 08 000	Delayed replication of 8 descriptors
	B 08 005	Meteorological attribute significance (storm centre)
	B 08 007	Dimensional significance (value for point)
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 01 026	WMO storm name (use “UNKNOWN” for a sandstorm)
	B 19 001	Synoptic features (value for type of storm)
	B 08 007	Dimensional significance (cancel)
	B 08 005	Meteorological attribute significance (cancel/end of object)

Comparison between Tables D of BUFR and CREX related to ***ITEM 12*** (continued)

BUFR Table D

In Category 16 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Cloud)
3 16 006	**1 12 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 011	Meteorological feature (value for cloud)
	0 08 007	Dimensional significance (value for area)
	0 07 002	Flight level (altitude) (base of layer)
	0 07 002	Flight level (altitude) (top of layer)
	1 02 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 20 011	Cloud amount
	0 20 012	Cloud type
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Front)
3 16 007	**1 10 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 011	Meteorological feature (value for type of front)
	0 08 007	Dimensional significance (value for line)
	1 04 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 19 005	Direction of feature
	0 19 006	Speed of feature
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Tropopause)
3 16 008	**1 11 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 001	Vertical significance (bit 3 set for tropopause)
	0 08 007	Dimensional significance (value for point)
	0 08 023	Statistic (type of tropopause value)
	1 03 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 10 002	Height/altitude
	0 08 023	Statistic (cancel)
	0 08 007	Dimensional significance (cancel)
	0 08 001	Vertical significance (cancel/end of object)

CREX Table D

In Category 16 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Cloud)
D 16 006	**R 11 000**	**Delayed replication of 11 descriptors**
	B 08 011	Meteorological feature (value for cloud)
	B 08 007	Dimensional significance (value for area)
	B 07 002	Flight level (altitude) (base of layer)
	B 07 002	Flight level (altitude) (top of layer)
	R 02 000	Delayed replication of 2 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 20 011	Cloud amount
	B 20 012	Cloud type
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Front)
D 16 007	**R 09 000**	**Delayed replication of 9 descriptors**
	B 08 011	Meteorological feature (value for type of front)
	B 08 007	Dimensional significance (value for line)
	R 04 000	Delayed replication of 4 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 19 005	Direction of feature
	B 19 006	Speed of feature
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Tropopause)
D 16 008	**R 10 000**	**Delayed replication of 10 descriptors**
	B 08 001	Vertical significance (bit 3 set for tropopause)
	B 08 007	Dimensional significance (value for point)
	B 08 023	Statistic (type of tropopause value)
	R 03 000	Delayed replication of 3 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 10 002	Height/altitude
	B 08 023	Statistic (cancel)
	B 08 007	Dimensional significance (cancel)
	B 08 001	Vertical significance (cancel/end of object)

Comparison between Tables D of BUFR and CREX related to ***ITEM 12*** (continued)

BUFR Table D

In Category 16 of BUFR Table D

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
		(Airframe icing area)
3 16 009	**1 11 000**	**Delayed replication**
	0 31 001	**Replication**
	0 08 011	Meteorological feature (value for airframe icing)
	0 08 007	Dimensional significance (value for area)
	0 07 002	Flight level (altitude) (base of layer)
	0 07 002	Flight level (altitude) (top of layer)
	1 02 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 20 041	Airframe icing (type of airframe icing)
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Name of feature)
3 16 010	1 07 000	Delayed replication
	0 31 001	**Replication**
	0 08 011	Meteorological feature
	0 08 007	Dimensional significance (value for point)
	0 01 022	Name of feature
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)
		(Volcano erupting)
3 16 011	1 16 000	Delayed replication
	0 31 001	**Replication**
	0 08 011	Meteorological feature (value for special clouds)
	0 01 022	Name of feature (volcano name)
	0 08 007	Dimensional significance (value for point)
	1 02 000	Delayed replication
	0 31 001	**Replication**
	0 05 002	Latitude (coarse)
	0 06 002	Longitude (coarse)
	0 08 021	Time significance (eruption starting time)
	0 04 001	Year
	0 04 002	Month
	0 04 003	Day
	0 04 004	Hour
	0 04 005	Minute
	0 20 090	Special clouds (clouds from volcanic eruptions)
	0 08 021	Time significance (cancel)
	0 08 007	Dimensional significance (cancel)
	0 08 011	Meteorological feature (cancel/end of object)

CREX Table D

In Category 16 of CREX Table D

SEQUENCE	TABLE REFERENCES F X Y	ELEMENT NAME
		(Airframe icing area)
D 16 009	**R 10 000**	**Delayed replication of 10 descriptors**
	B 08 011	Meteorological feature (value for airframe icing)
	B 08 007	Dimensional significance (value for area)
	B 07 002	Flight level (altitude) (base of layer)
	B 07 002	Flight level (altitude) (top of layer)
	R 02 000	Delayed replication of 2 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 20 041	Airframe icing (type of airframe icing)
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Name of feature)
D 16 010	R 07 000	Delayed replication of 7 descriptors
	B 08 011	Meteorological feature
	B 08 007	Dimensional significance (value for point)
	B 01 022	Name of feature
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)
		(Volcano erupting)
D 16 011	R 16 000	Delayed replication of 16 descriptors
	B 08 011	Meteorological feature (value for special clouds)
	B 01 022	Name of feature (volcano name)
	B 08 007	Dimensional significance (value for point)
	R 02 000	Delayed replication of 2 descriptors
	B 05 002	Latitude (coarse)
	B 06 002	Longitude (coarse)
	B 08 021	Time significance (eruption starting time)
	B 04 001	Year
	B 04 002	Month
	B 04 003	Day
	B 04 004	Hour
	B 04 005	Minute
	B 20 090	Special clouds (clouds from volcanic eruptions)
	B 08 021	Time significance (cancel)
	B 08 007	Dimensional significance (cancel)
	B 08 011	Meteorological feature (cancel/end of object)

ANNEX TO PARAGRAPH 7.3.2

SYNOPTIC OBSERVATIONS

R E G U L A T I O N S :

12.1 General

12.1.1 Synoptic observations can be performed by a land station, a sea station, a ship or a mobile land station. Identification of the stations or ship shall be provided by transmitting station, platform or ship official identifier, latitude (high accuracy), longitude, altitude of barometer and if necessary height of sensor; altitude of station ground and indeed time of observation, in the synoptic report.

12.1.2 Content of an observation

12.1.3.1 Reports from a fixed or mobile land station shall always contain at least (Common sequence CCCCC1):
- Type of station
- Base of lowest cloud
- Visibility
- Total cloud cover
- Wind direction
- Wind speed
- Dry bulb air temperature
- Dew-point or relative humidity
- Pressure at Mean-sea level or geopotential height of an agreed standard isobaric surface
- Pressure tendency
- Pressure at station level (barometer level)
- Present Weather
- Past Weather
- Precipitation data
- Amount of low and medium level clouds
- Types of low, medium and high clouds

12.1.3.2 When a report from a coastal land station contains maritime data, that report shall also Include (Common sequence CCCCC2):
- Sea surface temperature
- Wind waves and swell waves

12.1.3.3 Mobile land station reports shall include in addition to Common sequence CCCCC1, also Common sequence CCCCC4 containing data on radiation, sunshine, evaporation or evapotranspiration and supplementary information.

12.1.3.4 Reports from a sea station shall, in addition to Common sequences CCCCC1 and CCCCC2, also include Common sequence CCCCC3:
- ice accretion on ship
- wet bulb temperature

12.1.3.5 Ocean weather station reports shall include in addition to Common sequences CCCCC1, CCCCC2 and CCCCC3, Common sequence CCCCC4.

12.1.3.6 In reports from supplementary ships, Common sequence CCCCC1 shall contain, at least, data on:
- Type of station
- Base of lowest cloud
- Visibility
- Total cloud cover
- Wind direction
- Wind speed
- Dry bulb air temperature
- Pressure at Mean-sea level
- Present Weather
- Past Weather
- Amount of low and medium level clouds
- Types of low, medium and high clouds

12.1.3.7 In reports from auxiliary ships, Common sequence CCCCC1 shall contain, at least, data on:
- Type of station
- Base of lowest cloud
- Visibility
- Total cloud cover

- Wind direction
- Wind speed
- Dry bulb air temperature
- Pressure at Mean-sea level
- Present Weather
- Past Weather

N O T E S :
The above-mentioned content of Common sequence CCCCC1 is considered suitable for any ship which is not supplied with tested instruments and may be requested to report in areas where shipping is relatively sparse, or on request, and especially when storm conditions threaten or prevail. These ships may report in plain language if the use of code is impracticable.

12.1.4 Reports from automatic stations should contain Common sequence CCCCC5.

12.1.5 The actual time of observation shall be the time at which the barometer is read.

12.2

12.2.1

12.2.1.1 *Base of lowest cloud:*
When the station is in fog, a sandstorm or a duststorm or in blowing snow but the sky is discernible, the base of the lowest cloud shall be reported, if any. When, under the above conditions, the sky is not discernible, the base of the lowest cloud shall be reported as missing????????????? (PROBLEM??).
N O T E : See regulations relative to the use of ~~Section 4.~~????????

12.2.1.3 *Visibility:*

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

~~**12.2.1.3.2** In reporting visibility at sea, the decile 90–99 shall be used for VV.~~
12.2.2 ~~***Group*** Nddff~~
~~**12.2.2.1** This group shall always be included in the report~~.
12.2.2.1 *Total cloud cover??????? (where is it in BUFR, template????) :*

12.2.2.2.1 It 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 *Total cloud cover* = 7 (??????????? PROBLEM) 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 coded as 0 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 The 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 figures for medium and high clouds.

12.2.2.3 *Wind direction and speed:*

12.2.2.3.1 The mean direction and speed of the wind over the 10-minute period immediately preceding the observation shall be reported for wind. 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 ~~or knots~~ by the use of the wind speed equivalent columns of the Beaufort scale, and this speed is reported.
~~**12.2.2.3.3** When the wind speed, in units indicated by i_w, is 99 units or more:~~
~~(a) ff in the group Nddff shall be encoded 99;~~
~~(b) The group 00fff shall be included immediately following the group Nddff.~~
N O T E : The apparent wind speed measured on board a moving ship is to be corrected for the course and the speed of the ship, in order to obtain the speed of the true wind, which is to be reported. The correction can be made on the basis of the parallelogram of velocities or by means of special tables.

12.2.3

12.2.3.1 See Regulation 12.2.3.5 relative to pressure tendency ~~group 5appp~~.

12.2.3.2 *Group* 1s$_n$TTT

When the data are not available as a result of a temporary instrument failure, automatic weather stations programmed to transmit this group shall either omit the group altogether or include it in their reports in the form 1///.??????????? Missing in BUFR!!!

12.2.3.2 *Group* 2s$_n$T$_d$T$_d$T$_d$

12.2.3.2.1 Under unusual conditions, when the dew-point temperature is temporarily unavailable (e.g. because of instrument failure) but relative humidity is available, the group 29UUU relative humidity shall be reported instead replace the group 2s$_n$T$_d$T$_d$T$_d$. Every attempt shall first be made, however, to convert relative humidity to dew-point temperature, and the relative humidity included only as a last resort.

ANNEX

LIST OF ACRONYMS

ACARS	AirCraft Addressing and Reporting System
AFWA	Air Force Weather Agency
ANSI	American National Standards Institute
API	Application Program Interface
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
CIMO	Commission for Instruments and Methods of Observations
COST	European Co-Operation in the field of Scientific and Technical research
CREX	Character Representation form for data EXchange
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
EC	Executive Council of the WMO
ECMWF	European Centre for Medium-range Weather Forecast
EPS	Ensemble Prediction System
ESA	European Space Agency
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
FNMOC	Fleet Numerical Meteorology and Oceanography Centre
FORTRAN	FORmula TRANslation
FTP	File Transfer Protocol
GDPS	Global Data Processing System
GDT	Grid Definition Template
GIF	Graphic Interchange Format
GIS	Geographic Information System
GOS	Global Observing System
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
HTML	Hyper Text Markup Language
ICAO	International Civil Aviation Organisation
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
IOC	International Oceanographic Commission
ISO	International Standards Organization
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*
MS/DOS	/Disk Operating System
MSS	Message Switching System
MTDCF	Migration to Table Driven Code Forms
MTN	Main Telecommunications Network (of the GTS)
NASA	National Aeronautics and Space Administration
NCEP	National Centre for Environment Prediction
NESDIS	National Environmental Satellite Data and Information Service
NMC	National Meteorological Centre
NMHS	National Meteorological or Hydrological Service
NMS	National Meteorological Service
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
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
TCP	Tropical Cyclone Programme
TCP/IP	Transport Control Protocol/Internet Protocol
TDL	Techniques Development Laboratory
TIFF	Tagged Image File Format
UKMO	United Kingdom Meteorological Office
UNIX	*Not an acronym – name of an operating system*
UTC	Universal Time Coordinate
VOS	Voluntary Observing Ship
WAFS	World Area Forecasting System
WGDM	Working Group on Data Management (CBS)
WGS	Working Group on Standards
WMO	World Meteorological Organization
WWW	World Weather Watch
W3C	World Wide Web Consortium
XML	eXtensible Markup Language