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| WORLD METEOROLOGICAL ORGANIZATION  COMMISSION FOR BASIC SYSTEMS  -----------------------------  THIRD MEETING OF  INTER-PROGRAMME EXPERT TEAM ON DATA REPRESENTATION MAINTENANCE AND MONITORING  BEIJING, CHINA, 20 - 24 JULY 2015 |  | IPET-DRMM-III / Doc.3.2(6)  (29.06.2015)  -------------------------    ITEM 3.2    ENGLISH ONLY |

**Modification to wave spectra observation template (3 08 015 and 3 08 016)**

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**Summary and Purpose of Document**

This document proposes some modifications to wave spectra observation template (3 08 015 and 3 08 016) based on the validation.

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**ACTION PROPOSED**

The meeting is requested to review the proposal and approve it for pre-operation.

# Encoding wave spectra in BUFR

Attempts to validate the encoding of wave observations in BUFR have revealed that the proposed templates 3 08 015 and 3 08 016 have problems. In particular the ranges and precision represented by several table B descriptors are inadequate.

Several possible solutions were identified. The following proposal seemed to have the most support amongst the expert team as a short term solution. In the longer term, a solution involving a general method of handling elements with a large range but limited relative precision is highly desirable.

It has been extremely difficult to obtain any useful information on the appropriate ranges, absolute and relative precisions. There are four types of elements involved, non-directional and directional spectral energy densities in frequency and wavenumber representations. In the WAVEOB code, all these are represented in a scaled magnitude form with a range from 0 to (0.000 by 10-5) to 9 990 (0.999 by 104), with a precision of 10-8 (0.001 by 10-5) at bottom of the range and 3 decimal digits (approximately 10 bits) at the top.

A related issue is whether the templates should be purely intended for the translation of data presently encoded in WAVEOB, or whether they should be regarded as more general templates. In the latter case, it would probably be best to re-design the templates somewhat to remove some features that are artefacts of the WAVEOB representation.

Based on various sources of information, and a lot of guesswork, the extreme ranges and precision requirements might be as described in the table below. Note that the ranges given generally exceed those representable by the WAVEOB code. It would be very desirable, if at all possible, to get definitive requirements.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element | Unit | Maximum | Precision near zero | Precision at max  (decimal digits) |
| Non-directional spectral energy density based on frequency | m2 s | 5 000 | 10-5 | 4 |
| Non-directional spectral energy density based on wavenumber | m3 | 40 000 | 10-6 | 4 |
| Directional spectral energy density based on frequency | m2 s radian-1 | 80 000 | 10-5 | 4 |
| Directional spectral energy density based on wavenumber | m4 | 100 000 000 | 10-5 | 4 |

# Proposed changes

Add to BUFR table B

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Table Reference |  |  |  |  |  |
| Class | F X Y | Element name | Unit | Scale | Reference | Data width |
| 22 | 0 22 102 | Scaled maximum non-directional spectral wave density by frequency (Note 1) | m2 s | 0 | 0 | 14 |
| 22 | 0 22 103 | Scaled maximum non-directional spectral wave density by wavenumber (Note 1) | m3 | 0 | 0 | 14 |
| 22 | 0 22 104 | Scaled non-directional spectral wave density by frequency (Note 1) | m2 s | 0 | 0 | 14 |
| 22 | 0 22 105 | Scaled non-directional spectral wave density by wavenumber (Note 1) | m3 | 0 | 0 | 14 |
| 22 | 0 22 106 | Scaled directional spectral wave density by frequency (Note 1) | m2 s radian-1 | 0 | 0 | 14 |
| 22 | 0 22 107 | Scaled directional spectral wave density by wavenumber (Note 1) | m4 | 0 | 0 | 14 |

Notes

1. Must be preceded by 0 08 090, possibly with intervening operators. The value is 10x multiplied by the encoded value, where x is the value associated with the preceding 0 08 090 descriptor. The encoded value is the actual value multiplied by 10-x.

With the above values, the representable range of values for the scale is -127 to +127 and the representable values for the spectral energy densities range from 0 with a precision of 10-127 through to (214-2)\*10127 (1.6382\*10131) with a precision of 10127 (approximately 4 decimal digits), far in excess of requirements. Of course other values could be chosen to reduce BUFR message size, including a narrower width version of 0 08 090. Reducing the decimal scale to 4 bits with a reference of -7 would give 0 with a precision of 10-7 through 1.6382\*1011 with a precision of 107 (still approximately 4 decimal digits), which would still be adequate. Reducing the data width for the spectral energy densities would reduce the precision below 4 decimal digits. We believe that each use of 0 08 090 will have to be followed (after the affected descriptors) with another use with the scale set to zero or missing as class 8 descriptors remain in effect until reset.

Amend un-validated template 3 08 015

|  |  |  |  |
| --- | --- | --- | --- |
| Table reference |  |  |  |
| F X Y | Table reference | Element name | Note or WAVEOB ref |
|  |  | *Identification (WAVEOB Section 0)* |  |
| 3 08 015 | 0 01 003 | WMO Region number/geographical area | A­­1 |
|  | 0 01 020 | WMO Region sub-area | bw |
|  | 0 01 005 | Buoy/platform identifier | nbnbnb |
|  | 0 01 011 | Ship or mobile land station identifier | D…D |
|  | 0 01 007 | Satellite identifier | I6I6I6 |
|  | 0 01 001 | WMO block number | II |
|  | 0 01 002 | WMO station number | Iii |
|  | 0 02 044 | Indicator for method of calculating spectrum | Im |
|  | 0 02 045 | Indicator for type of platform | Ip |
|  | 3 01 011 | Year, month, day | JMMYY |
|  | 3 01 012 | Hour, minute | GGgg |
|  | 3 01 021 | Latitude/longitude (high accuracy) | QcLaLaLaLa LoLoLoLoLo |
|  |  | *Basic data (WAVEOB Section 0)* |  |
|  | 0 22 063 | Total water depth | 1hhhh |
|  | 0 22 076 | Direction of coming dominant waves | 9dddd |
|  | 0 22 077 | Directional spread of dominant wave | dsds |
|  | 0 22 094 | Total number of wave bands | 111BTBT |
|  | 0 25 044 | Wave sampling interval | SSSS |
|  | 0 22 079 | Length of wave record | D’D’D’D’ |
|  | 1 07 002 | Replicate 5 descriptors 2 times | Over sensor type |
|  | 0 02 046 | Wave measurement instrumentation |  |
|  | 0 22 070 | Significant wave height | 2Hs HsHsHs or 6HseHseHseHse |
|  | 0 22 072 | Spectral peak wave length | 3PpPpPpPp or 7PspPspPspPsp |
|  | 0 22 073 | Maximum wave height | 4HmHmHmHm |
|  | 0 22 075 | Average wave period | 5PaPaPaPa or 8PsaPsaPsaPsa |
|  |  | *Spectral data (WAVEOB Sections 1-5)* |  |
|  | 1 24 000 | Delayed replication of 24 descriptors | Note 1 |
|  | 0 31 001 | Replication factor | 0, 1 or 2; normally 1 |
|  | 0 02 046 | Wave measurement instrumentation | 2222 or 3333 |
|  | 0 08 090 | Scale to be applied to following element descriptors | x |
|  | 0 22 102 | Maximum non-directional spectral wave density by frequency m2 s | x CmCmCmCm or  x CsmCsmCsmCsm |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 084 | Band containing maximum non-directional spectral wave density | nmnm or nsmnsm |
|  | 1 18 000 | Delayed replication of 18 descriptors |  |
|  | 0 31 001 | Delayed descriptor replication factor | 111BTBT |
|  | 0 22 080 | Waveband central frequency | BB/// 1f1f1f1x 1fdfdfdx… |
|  | 0 22 085 | Spectral wave density ratio | 1c1c1c2c2 or 1cs1cs1cs2cs2 … |
|  | 0 02 086 | Mean direction from which waves are coming | 1da1da1 … |
|  | 0 02 087 | Principal direction from which waves are coming | da2da2… |
|  | 0 22 088 | First normalized polar coordinate from Fourier coefficients | 1r1r1 … |
|  | 0 22 089 | Second normalized polar coordinate from Fourier coefficients | r2r2… |
|  | 1 04 000 | Delayed replication of 4 descriptors | Note 2 |
|  | 0 31 001 | Delayed descriptor replication factor | Ib Note 2 |
|  | 0 08 090 | Scale to be applied to following element descriptors | x |
|  | 0 22 104 | Non-directional spectral estimate by frequency | 1A1A1A1x … |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 186 | Direction from which waves are coming | Note 3 |
|  | 0 22 187 | Directional spread of wave | Note 3 |
|  | 1 04 000 | Delayed replication of 4 descriptors | Note 4 |
|  | 0 31 001 | Delayed descriptor replication factor | Ib Note 4 |
|  | 0 08 090 | Scale to be applied to following element descriptors | x |
|  | 0 22 106 | Directional spectral estimate by frequency | 1A1A1A1x … |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 186 | Direction from which waves are coming | 1d1d1 … |
|  | 0 22 187 | Directional spread of wave | dsds … |

Notes:

1. Normally 1, may be 2 if both heave and slope sensors are in use, or 0 if no spectral data.
2. Non-directional spectra, (Ib=0 in WAVEOB) or partial directional spectra (Ib=1 in WAVEOB with one direction per wavenumber). Count=0 (full directional spectra) or 1 (non-directional spectra or partial directional spectra). Partial directional spectra have only one direction per wavenumber band.
3. Missing for non-directional spectra.
4. Full directional spectra (Ib=1 in WAVEOB with more than one direction per wavenumber band). The replication count is the number of directions per wavenumber band which should normally cover the full circle.

Amend un-validated template 3 08 016

|  |  |  |  |
| --- | --- | --- | --- |
| Table reference |  |  |  |
| F X Y | Table reference | Element name | Note or WAVEOB ref |
|  |  | *Identification (WAVEOB Section 0)* |  |
| 3 08 016 | 0 01 003 | WMO Region number/geographical area | A­­1 |
|  | 0 01 020 | WMO Region sub-area | bw |
|  | 0 01 005 | Buoy/platform identifier | nbnbnb |
|  | 0 01 011 | Ship or mobile land station identifier | D…D |
|  | 0 01 007 | Satellite identifier | I6I6I6 |
|  | 0 01 001 | WMO block number | II |
|  | 0 01 002 | WMO station number | iii |
|  | 0 02 044 | Indicator for method of calculating spectrum | Im |
|  | 0 02 045 | Indicator for type of platform | Ip |
|  | 3 01 011 | Year, month, day | JMMYY |
|  | 3 01 012 | Hour, minute | GGgg |
|  | 3 01 021 | Latitude/longitude (high accuracy) | QcLaLaLaLa LoLoLoLoLo |
|  |  | *Basic data (WAVEOB Section 0)* |  |
|  | 0 22 063 | Total water depth | 1hhhh |
|  | 0 22 076 | Direction of coming dominant waves | 9dddd |
|  | 0 22 077 | Directional spread of dominant wave | dsds |
|  | 0 22 094 | Total number of wave bands | 111BTBT |
|  | 0 25 044 | Wave sampling interval | SSSS |
|  | 0 22 079 | Length of wave record | D’D’D’D’ |
|  | 1 07 002 | Replicate 5 descriptors 2 times | Over sensor type |
|  | 0 02 046 | Wave measurement instrumentation |  |
|  | 0 22 070 | Significant wave height | 2Hs HsHsHs or 6HseHseHseHse |
|  | 0 22 072 | Spectral peak wave length | 3PpPpPpPp or 7PspPspPspPsp |
|  | 0 22 073 | Maximum wave height | 4HmHmHmHm |
|  | 0 22 075 | Average wave period | 5PaPaPaPa or 8PsaPsaPsaPsa |
|  |  | *Spectral data (WAVEOB Sections 1-5)* |  |
|  | 1 24 000 | Delayed replication of 24 descriptors | Note 1 |
|  | 0 31 001 | Replication factor | 0, 1 or 2; normally 1 |
|  | 0 02 046 | Wave measurement instrumentation | 2222 or 3333 |
|  | 0 08 090 | Scale to be applied to following element descriptors | x |
|  | 0 22 103 | Maximum non-directional spectral wave density by wavenumber | x CmCmCmCm or  x CsmCsmCsmCsm |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 084 | Band containing maximum non-directional spectral wave density | nmnm or nsmnsm |
|  | 1 18 000 | Delayed replication of 18 descriptors |  |
|  | 0 31 001 | Delayed descriptor replication factor | 111BTBT |
|  | 0 22 081 | Waveband central wave number | BB/// 1f1f1f1x 1fdfdfdx… |
|  | 0 22 085 | Spectral wave density ratio | 1c1c1c2c2 or 1cs1cs1cs2cs2 … |
|  | 0 02 086 | Mean direction from which waves are coming | 1da1da1 … |
|  | 0 02 087 | Principal direction from which waves are coming | da2da2… |
|  | 0 22 088 | First normalized polar coordinate from Fourier coefficients | 1r1r1 … |
|  | 0 22 089 | Second normalized polar coordinate from Fourier coefficients | r2r2… |
|  | 1 03 000 | Delayed replication of 5 descriptors | Note 2 |
|  | 0 31 001 | Delayed descriptor replication factor | Ib Note 2 |
|  | 0 08 090 | Scale to be applied to next element descriptor | x |
|  | 0 22 105 | Non-directional spectral estimate by wave number | 1A1A1A1x … |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 186 | Direction from which waves are coming | Note 3 |
|  | 0 22 187 | Directional spread of wave | Note 3 |
|  | 1 03 000 | Delayed replication of 5 descriptors | Note 4 |
|  | 0 31 001 | Delayed descriptor replication factor | Ib Note 4 |
|  | 0 08 090 | Scale to be applied to next element descriptor | x |
|  | 0 22 107 | Directional spectral estimate by wave number | 1A1A1A1x … |
|  | 0 08 090 | Scale to be applied to following descriptors | Missing |
|  | 0 22 186 | Direction from which waves are coming | 1d1d1 … |
|  | 0 22 187 | Directional spread of wave | dsds … |

Notes:

Refer to notes for template 3 08 015.