ecCodes BUFR practicals

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ECMWF

INFO

- Install Jsonview in your firefox

- Tar with practicals:

    ```
    cp /home/ma/mac/public/bufr_practicals.tar .

    tar –x bufr_praticals.tar

    cd bufr_practicals
    ```

    In the data directory you have some bufr samples to be used in the practicals.

- Tar with presentations and WMO manual:

    ```
    /home/ma/mac/public/ecCodes_training_material.tar
    ```

- We are going to use mostly bufr_filter, but all the practicals could be done with Fortran or Python using the set/get functions and the same keys used in the practicals. The use of bufr_filter speeds up the learning process regarding the keys and doesn't have the clutter of a programming language.

1. bufr_dump and JSON output

1. bufr_dump synop.bufr > synop.bufr.json

2. Try to visualise synop.bufr.json in a web browser or use kate

3. Do the same with scatterometer.bufr, temp.bufr, multisubset.bufr

4. Use option –ja to dump all the attributes of the keys

2. Use bufr_filter to inspect a BUFR file

1. Print: unexpandedDescriptors, expandedDescriptors, expandedAbbreviations, expandedNames using bufr_filter from file synop.bufr

2. Print: latitude, longitude, airTemperature (remember to set unpack=1 to decode the data section).

3. Print units, code, width, reference and scale for airTemperature.

3. Use bufr_filter to inspect a BUFR file

1. Print: percentConfidence of pressure from the file synop_with_confidence.bufr

2. Print all the attributes of percentConfidence and pressure.

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4. Use bufr_filter to inspect a BUFR file

1. Print: latitude,longitude,airTemperature from temp.bufr

2. Have a look at the JSON dump and compare with the result from the bufr_filter

3. Print latitude,longitude,airTemperature for some specific levels using the search by rank and by condition. Compare with the JSON dump

4. From the file scatterometer.bufr print backscatter for beam 2. Compare with JSON dump.

5. Subsets for uncompressed data

1. Using bufr_filter print the name of the station, latitude, longitude, air temperature and dew point temperature for subset number 3 and 5.

2. Compare with the JSON dump

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6. Subsets for compressed data

1. Using bufr_filter print the values for all the subsets available in the message in scatterometer.bufr for latitude, longitude and backscatter for beam 2.

2. Compare with the JSON dump

Extract subsets

bufr_filter instructions file:

```
set unpack=1;


set extractSubset=4;
set doExtractSubsets=1;
write;


set extractSubsetIntervalStart=3;
set extractSubsetIntervalEnd=8;
set doExtractSubsets=1;
write;
```

7. Extract subsets from uncompressed data

- Using bufr_dump and bufr_filter extract the subset for stationNumber=270 from the file multisubsets.bufr

8. Extract subsets from compressed data

• Using bufr_filter extract the subsets from 10 to 20 (inclusive) from scatterometer.bufr

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9. Create a new message by setting unexpandedDescriptors

1. Use bufr_filter to set unexpandedDescriptors → 106002 008002 104003 005002 006002 010002 012001. Use synop.bufr as input file.

2. Write the result in a new message

3. Print unexpandedDescriptors, expandedDescriptors, expandedAbbreviations from the new message.

4. Have a look at the JSON dump and compare the original message with the new generated message

10. Set some content in the newly created message

1. In the message created in the previous practical set some values for the second instance of latitude,longitude, height, airTemperature.

2. Check the result printing with bufr_filter and with the JSON dump

11. Create a new uncompressed message

1. Using bufr_filter create a new message with unexpandedDescriptors={309052} (upper air profile)

2. Compare with the upper air example temp.bufr

12. Create a new uncompressed BUFR with appropriate replications

Delayed replication are all set to 1 when the unexpandedDescriptors are set to create a new message. In a real situation we need to have different values of delayed replication factors. To create a new message with given deleyed replication factors we can set the follwing three **vector** keys.

inputDelayedDescriptorReplicationFactor

inputExtendedDelayedDescriptorReplicationFactor

inputShortDelayedDescriptorReplicationFactor

These keys must be set before setting the unexpandedDescriptors and they must be set with vectors having the required number of elements for the data structure.

1. Using bufr_filter create a new upper air message (309052) with the same number of delayed replications as the example temp.bufr

13. Set some content in a message with replications

1. Create a new message 309052 copying from temp.bufr:

    – The number of replications

    – The values of timePeriod, geopotentialHeight, latitudeDisplacement, longitudeDisplacement, airTemperature

2. Have a look at the result with bufr_dump

14. Create and set multi-subsets message with replications

1. Create a new message 309052 with 2 subsets.

2. First subset: 3 levels, 2 wind shear levels

3. Second subset: 4 levels, 3 wind shear levels

4. Set some values of pressure for all the subsets and levels

5. Have a look at the result with bufr_dump

15. Create a new compressed BUFR

1. Create a new compressed message with unexpandedDescriptors={312061} (scatterometer data)
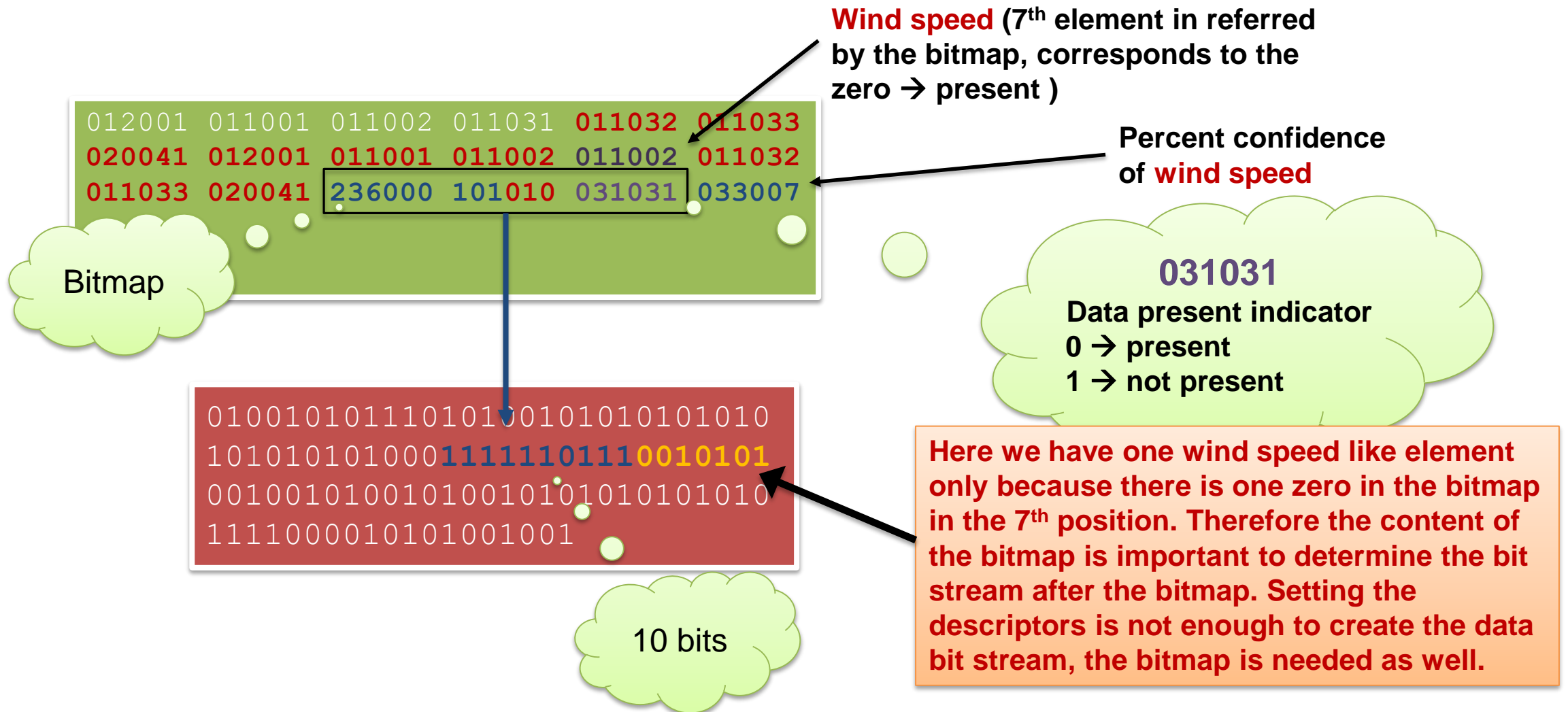
2. Compare with scatterometer.bufr

16. Create a new compressed BUFR with appropriate replications

1. Create a new compressed message with unexpandedDescriptors={312061} (scatterometer data), with 20 subsets and 5 delayed replications

2. Set the values of the second and forth windSpeedAt10M with an appropriate list of values

3. Have a look at the result using bufr_dump

17. Creating a BUFR with bitmap

1. Using bufr_filter create a new BUFR with the same unexpandedDescriptors as synop_with_confidence.bufr

2. Examine the output doing the bufr_dump

3. Considerations on the generated bitmap

BUFR bitmap and quality information

Wind speed (7th element in referred by the bitmap, corresponds to the zero → present)

Percent confidence of wind speed

```
012001 011001 011002 011031 011032 011033
020041 012001 011001 011002 011002 011032
011033 020041 236000 101010 031031 033007
```

Bitmap

```
0100101011101010010101010101010
101010101000111111011110010101
00100101001010010101010101010
1111000010101001001
```

10 bits

031031
Data present indicator
0 → present
1 → not present

Here we have one wind speed like element only because there is one zero in the bitmap in the 7th position. Therefore the content of the bitmap is important to determine the bit stream after the bitmap. Setting the descriptors is not enough to create the data bit stream, the bitmap is needed as well.

18. Creating a BUFR with bitmap

Unfortunately this is not working in release 0.13.0. It has already been fixed for release 0.14.0 coming soon.

1. Create a new message similar to the one created in the previous example, with percent confidence only for airTemperatureAt2M and dewpointTemperatureAt2M.

2. Set the key input dataPresentIndicator to define the bitmap before setting the unexpandedDescriptors.

19. Creating a BUFR with a bitmap with delayed replication

Unfortunately this is not working in release 0.13.0. It has already been fixed for release 0.14.0 coming soon.

```
set compressedData=1;
set localTablesVersionNumber=101;
set masterTablesVersionNumber=13;
set inputDelayedDescriptorReplicationFactor={4,1,4,15,2,2};
set inputDataPresentIndicator={1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1};
set numberOfSubsets=5;

set unexpandedDescriptors={1211, 310022, 301011, 301013, 301021, 102004, 27001, 28001,
7022, 5040,5043, 20010, 20016, 13040, 10001, 8043, 8044, 8023, 106000, 31001, 207002,
10004, 207000, 8090, 15008, 8090, 8023, 33054, 10040, 114000, 31001, 207002, 7004,
7004, 207000, 8090, 15008, 8090, 15043, 104000, 31001, 207002, 10004, 207000, 15044,
224000, 236000, 101000, 31001, 31031, 1033, 1032, 8023, 101000, 31001, 224255, 224000,
237000, 1033, 1032, 8023, 101000, 31001, 224255};

write;
```

20. Conversion from edition 3 to 4

1. In the directory conversion there is a bufr edition 3 file. Convert to edition 4 by setting edition=4 with the bufr_filter or the bufr_set

2. Compare original and created message with bufr_compare. Do also the comparison between created and original.

3. Compare the JSON dump of the messages.

21. Add local section to a BUFR message

1. Take a message from the data directory and add a local section by setting to 1 the key section2Present.

2. Compare created and original message.

Challenge

Data are in the directories c1, c2, c3 respectively.

1. Using the Fortran or Python interface extract from amsua.bufr a message containing the data in the time window between 13:00 and 13:50 (extremes included)

2. Using the Fortran or Python interface extract from synop_20160301.bufr a message containing the data with latitude between 40 and 45 degrees (extremes included).

3. Write latitude,longitude, airTemperature, dewpointTemperature, pressure from syno_20160301.bufr in a new message in compressed format. Write only the required variables in the output message.

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