

Wreport-Bufr2netcdf

*a free library and tools for decoding
BUFR reports and creating input files
for COSMO model assimilation*

- *Paolo Patrino*
- *Davide Cesari*

- ARPA-SIMC during the last 6 years has developed a set of tools for importing-exporting Hydrometeorological observations from different sources
- The low level encoding-decoding for BUFR data is performed by a C++ library called *Wreport*
- On the need, data are imported into a *physically-oriented* (VS. report-oriented) data model, called *DB-All.e* (DataBase-All.enhanced)

- The work has been done mainly by a freelance software developer, Enrico Zini
enrico@enricozini.org
- The development process has been carried out under the strict supervision of people from ARPA-SIMC, firstly Paolo Patruno.

- COSMO model requires observations in netcdf format (AOF is considered obsolete)
- The COSMO netcdf format is the translation of a BUFR structure in netcdf, difficult to write directly from user applications and not following any standard specification
- The physical interpretation of the data is done into the COSMO model (>14K lines)
- The natural source of observed data for COSMO model should be BUFR following a predefined template (e.g. WMO reports)

*So we need a common
BUFR pre-processor*

- Due to the uncomfortable licensing terms of *Bufrx2netcdf* provided by DWD, e.g.:
 - need to ask for a license
 - impossibility to share modifications within COSMO
 - impossibility to show it to other partners
- it has been decided with the approval of the Cosmo Steering Committee (04/2011) to complete Wreport with an exporter to the observation format required by COSMO for data assimilation
- This conversion is an almost literal translation of a BUFR into a netcdf data structure

- ***Wreport***: BUFR/CREX encoding-decoding library

- ***Bufr2netcdf***: BUFR preprocessor for observation COSMO data ingest

Additionally:

- ***DB-All.e***: import-export data in a physically-based data model, for higher level data processing

- ***C++ Library*** for encoding-decoding BUFR and CREX messages at low level
- It can use tables in ***standard XML format*** as distributed by WMO (easy maintenance)
- It includes a simple command line BUFR dumper
- It has a minimal dependency on external libraries
- It cannot convert BUFR between different templates

- The decoder supports **BUFR** editions 2, 3 and 4, both uncompressed and compressed
 - Almost all BUFR C operators supported

- The decoder supports **CREX** edition 1
 - B, R and D opcodes are supported plus some C modifiers

- Support for bitmaps and associated fields, quality information, substituted fields

- Implemented by looking only at provided input-output examples
- It produces the same netcdf output as DWD Bufrx2netcdf for:
acars, amdar, temp, synop, ship, buoy, tempship, pilot, rass, gps_zenith, radar_vad, wprof
- Template independent, so the maintenance work should be at minimum
- Easily installable (already pre-packaged for some Linux distributions)

- It can import observations from various sources into a ***unique, high-level, physically-based data model*** (lon, lat, time, level, parameter, etc.) and export them back
- It uses Wreport library for BUFR and CREX encoding-decoding
- It has a GUI for quickly navigating into observation datasets
- It depends on other external libraries

- It imports data from other formats, such as
 - Binary COSMO *AOF* (ro)
 - Text with predefined *csv* structure (rw)
- It understands *BUFR with different templates* (e.g. those from MARS at ECMWF)
- using command line tools it can convert from those formats to *BUFR in WMO/GTS template* required by COSMO model
- It has a *Fortran interface*
 - in principle, it could even be used within COSMO model itself for observation input

- All the software presented is provided under the GNU-GPL license:
 - It is can be freely used, modified and redistributed, also for commercial purposes, provided that the licensing terms are not modified and that the source code is always included
 - It can be freely used as a command line tool but it cannot be incorporated as a library into a proprietary application
- ARPA-SIMC holds the copyright and, if needed, may agree to relax the last requirement for COSMO partners (i.e. license it under LGPL)

ARPA-SIMC proposes to insert
Wreport + Bufr2netcdf
into the list of COSMO code

We propose not to include the DB-All.e component, since it is a complex package with many external dependencies.

This, however, does not prevent COSMO partners from installing also that component and getting the additional benefits from it.

```

call idba_error_set_callback(0, errorrep, 0, i)

!      Open a session
call idba_messaggi(handle, fname, "r", "BUFR")

!      Query all the stations
do while (.true.)
  call idba_quantesimo(handle, nstaz)
  if (nstaz .eq. 0) exit

  call idba_elencamele(handle)
  call idba_enq(handle, "name", cname)
  call idba_enq(handle, "lat", dlat)
  call idba_enq(handle, "lon", dlon)
  call idba_enq(handle, "height", height)
  call idba_enq(handle, "rep_memo", rep_memo)

  write (*,*) "Staz: ", trim(cname), " (", dlat, ",", dlon, ")", " h:", height, " network: ", rep_memo
  !call idba_set(handle, "varlist", "B12101,B11002") ! only on DB is valid

  call idba_voglioquesto(handle, ndata)
  !write (*,*) " ", ndata, " dati:" ! only on DB is valid
  do il=1, ndata
    call idba_dammelo(handle, btable)
    if (btable /= "B12101" .and. btable /= "B11002") cycle

    call idba_enqdate(handle, year, month, day, hour, minute, second)
    call idba_enqlevel(handle, type1, l1, type2, l2)
    call idba_enq(handle, btable, value)

    print*, "----"
    write (*,*) "date time: ", year, month, day, hour, minute
    call idba_spiegab(handle, type1, l1, type2, l2, prettyvalue)
    write (*,*) trim(prettyvalue)
    call idba_spiegab(handle, btable, value, prettyvalue)
    write (*,*) trim(prettyvalue)

    call idba_voglioancora (handle, nattr)
    if (nattr > 0) then
      write (*,*) " ", nattr, " attributi:"
      do i2=1, nattr
        call idba_ancora(handle, starbtable)
        call idba_enq(handle, starbtable, avalue)
        write(*,*) " attr ", trim(starbtable), ": ", avalue
      enddo
    end if
  enddo
enddo

call idba_fatto(handle)

```

```

--- dumpmsg_dballe.f90 23% L23 (F90)---

```

```
./dumpmsg_dballe example_temp.bufr
```

```
Staz: ( 44.649999999999999 , 11.616669999999999 ) h: 2147483647 network: temp
```

```
----  
date time:      2011      3      22      0      0  
Isobaric surface, 29.40hPa  
216.50 (K) TEMPERATURE/DRY-BULB TEMPERATURE
```

```
----  
date time:      2011      3      22      0      0  
Isobaric surface, 30.00hPa  
3.1 (M/S) WIND SPEED
```

```
----  
date time:      2011      3      22      0      0  
Isobaric surface, 30.00hPa  
216.90 (K) TEMPERATURE/DRY-BULB TEMPERATURE
```

```
----  
date time:      2011      3      22      0      0  
Isobaric surface, 34.30hPa  
7.7 (M/S) WIND SPEED
```

Etc. etc.