

An Introduction to Advanced UNIX

Part 2

Kevin Keay

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Introduction

This is a compilation of some useful software for the Meteorology Honours students. It includes programs for decoding GRIB and NetCDF data files, which are the common formats of most reanalysis products, as well as data manipulation and plotting packages. These packages may be used in conjunction with your own Fortran or C programs or existing software written by others in the Meteorology group.

Some general remarks about software

Most of our software is available on both the SUNs (Solaris OS) and Linux machines. A program usually has the same name e.g. `grads`, and versions are normally similar in terms of release date. The only major exception at present is `conmap` on `atlas` – use `orthus` instead. In addition there are several versions of the `conmap` program in existence. On the Linux machines, use `conmap7`. Furthermore, `CDO` and `NCL` are only available on the Solaris machines at present.

Generally speaking, you should use the Linux machines for your work.

However, `atlas` may be faster for IO intensive procedures such as decoding large GRIB or NetCDF files.

Some of the packages e.g. GrADS, are also available for a Windows PC or a Mac.

Note that binary files produced by Fortran and C programs on the SUNs ('big-endian') are incompatible with programs to process them on the Linux machines ('little-endian'). The most common instance of this problem is with `CMP` (`conmap`) files. Use `binswap` on either 'end'. For example:

```
binswap -c pmsl.ncep.sun.cmp pmsl.ncep.linux.cmp
```

where `binswap` is run on the Linux machine.

The output `CMP` file (`pmsl.ncep.linux.cmp`) can now be read on a Linux machine.

The reverse procedure is also true: a Linux `CMP` file may be converted on a SUN with `binswap`.

A summary of useful software for the Meteorology Honours students

<code>ausmap</code>	Create a plot of a CMP file over the Australian region
CDO*	Climate Data Operators
<code>cmp2cdl4</code>	Convert a CMP file to CDL, then to NetCDF via <code>ncgen</code>
<code>conmap</code>	Create a general plot of a CMP file; normal version is <code>conmap7</code>
GMT	Generic Mapping Tools: used for mapping and some data processing
GrADS	A mapping and data processing package; can read common NetCDF files
GRIB	A common data format – see: <code>wgrib</code> , <code>readgribn7</code>
Matlab	A sophisticated data processing and mapping package
NCL*	NCAR Command Language
NCO	NetCDF operators e.g. <code>ncks</code> ; used for manipulating NetCDF files
NetCDF	A common data format; includes the utilities <code>ncdump</code> and <code>ncgen</code> – see: <code>read_nc2cmp</code> ; also GrADS
Panoply	A NetCDF mapping tool; a large selection of map projections and palettes
<code>readcmp</code>	Produces a dump (text listing) of the contents of a single map CMP file
<code>readgribn7</code>	Used in conjunction with <code>wgrib</code> to decode common GRIB files to CMP format
<code>read_nc2cmp</code>	Decode common NetCDF files to CMP format
<code>splitcon</code>	Extracts maps from a multi-map CMP file to separate CMP files
<code>wgrib</code>	Used in conjunction with <code>readgribn7</code> to decode common GRIB files to CMP format
<code>xconv</code>	Convert a GRIB file to a NetCDF file
<code>xmgr</code>	A general plotting package

*Currently available on Solaris (SUN) machines only at this time

A brief description of the software

In general these notes are not detailed. It is recommended that you read the documentation.

ausmap

This is a version of `conmap` written by David Jones of the Bureau of Meteorology. It is intended for plotting CMP (`conmap`) files over the Australian region. There are some features such as a raster plot (`-X` option) which are not available in `conmap`.

Usage: `ausmap [options] cmpfile [< instruction_file]`

Documentation: <http://www.earthsci.unimelb.edu.au/~kevin/ausmap/ausmap.htm>

CDO

The CDO (Climate Data Operators) package contains GRIB and NetCDF manipulation utilities. Currently it is available only on Solaris (SUN) machines. Type: `cdo` for a brief help screen and see the CDO website for documentation.

Documentation: <http://www.mpimet.mpg.de/fileadmin/software/cdo/>

cmp2cdl4

This is a utility to translate a single or multi-map CMP (`conmap`) file into a NetCDF CDL text file. The CDL file may then be converted by `ncgen` into a binary NetCDF file for input to GrADS, Matlab, NCO or Panoply.

Usage: `cmp2cdl4 [-h] -n nmlist -i cmpfile -o cdlfile`

Documentation:

For a help screen: `cmp2cdl4 -h`

Namelist details:

```
namelist /nmcdl/ var,  
* attr_var_long_name, attr_var_units,
```

```
* gattr_desc, gattr_hist,  
* date_time_fmt, date_time_type,  
* nc_name, time_unlimited,  
* map1, map2
```

Example namelist:

```
&nmcdl  
  var= 'H',  
  date_time_type= 'YM',  
  date_time_fmt= '(18x,I4,I2)',  
  attr_var_long_name= 'H',  
  attr_var_units= 'per Kelvin',  
  gattr_desc= 'Monthly H (year-month) based  
on monthly HadISST T and NCEP  
Reanalysis E; Period Jan 1979 - Dec 2005',  
  nc_name= 'my_H',  
  map1= 5,  
  map2= 10,  
  time_unlimited=F,  
  gattr_hist= 'Created by Kevin Keay',  
&end
```

Example: `cmp2cdl4 -n nmlist.txt -i cstatdat.cmp -o test.cdl`

```
ncgen -b test.cdl (uses name in CDL file)
```

```
ncgen -o test.nc test.cdl
```

conmap

This is a program based on NCAR Graphics for plotting gridded binary files in a simple format called ‘conmap’ (CMP, also known as CIF at CSIRO or the Bureau of Meteorology). There are a number of versions in use:

Orthus (Solaris OS)

`conmap`: Original program

`conmap_kk`: An early enhanced version by Kevin Keay

Linux machines

`conmap`: Similar to `conmap_kk` on orthus

`conmap_kk`: An alias of `conmap`

`conmap5`: A later version (v. 5, 2005). Use this for vector plots (-V option)

`conmap7`: Most recent version (v.7.04, 2006). In general, use this one except for vector plots.

Usage: conmap [options] cmpfile [< instruction_file]
conmap7[-k namelist_file][options] cmpfile [< ins_file]

Documentation: http://www.earthsci.unimelb.edu.au/~kevin/conmap_man.pdf

This covers the main options but needs to be updated.

For brief help on conmap7:

```
conmap7 -help          and:  
conmap7 --namelist
```

to see some information about the namelist parameters (options -k, -K).

GMT

The Generic Mapping Tools (GMT) is actually a free collection of utilities that may be incorporated into C-shell scripts like UNIX commands. These tools may be used for plotting gridded data as well as performing some data processing. NetCDF support (input and output) is supported. Currently GMT is only available for the Linux machines (version 4.2.0).

Usage: Look at the documentation, especially the mapping tutorial (GMT Tutorial):

Documentation: http://www.earthsci.unimelb.edu.au/~kevin/GMT_Help/gmt_services.html

The following C-shell commands need to go in the initialisation file called ~/.cshrc.linux:

```
# GMT under Linux  
# Location of required NetCDF library (3.6.x)  
setenv NETCDFHOME /work18/kevin/netCDF  
# Add NetCDF library to LD_LIBRARY_PATH  
setenv LD_LIBRARY_PATH $NETCDFHOME/lib:$LD_LIBRARY_PATH  
# Add GMT binaries to PATH  
setenv PATH /work18/kevin/GMT/GMT4.2.0/bin:$PATH  
# Add GMT man pages to MANPATH
```

```
setenv MANPATH /work18/kevin/GMT/GMT4.2.0/man:$MANPATH
```

GrADS

GrADS is a free package that can be used to plot gridded data and also perform data processing. It has a scripting language so that complex procedures can be created. A useful feature is `sdfopen` which allows common NetCDF files to be read. There is a version for Windows and the Mac too. The current version is 1.9b4.

Usage: `grads`

Also see the documentation especially the tutorial.

Documentation: <http://www.iges.org/grads/gadoc/index.html>

GRIB

This is the standard WMO binary gridded data format. It is converted to ‘conmap’ (CMP format) in a two stage process using `wgrib` and `readgribn7`. See Part 3 for more details.

Matlab

Matlab is a powerful and comprehensive package to do just about anything in physics and engineering. Some of our staff and PhD students have made use of the software for various projects. It has very basic NetCDF support but may require manual application of attributes such as offset and scaling factors.

To start with a GUI: `matlab`

To start without the GUI: `matlab -nodesktop -nosplash`

Documentation: <http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.html>

There is also local documentation that is accessed from `matlab` during execution.

Tutorials: http://www.mathworks.com/academia/student_center/tutorials/launchpad.html

NCL

NCL (NCAR Command Language) is the successor to NCAR Graphics. It also has NetCDF manipulation utilities. Currently it is available only on Solaris (SUN) machines. See the NCL website for documentation.

Documentation: <http://www.ncl.ucar.edu/Document/index.shtml>

NCO

NCO (NetCDF Operators) is a suite of programs known as *operators* that can be used to manipulate NetCDF data files. A useful simple application is to change dimension names if they don't conform with a package like GrADS. Another is to extract a level from a multi-level data file.

Usage: `ncks` and `ncrename` are probably the most useful utilities. Also see the documentation.

Documentation: <http://nco.sourceforge.net/nco.html>

NetCDF

The NetCDF format is commonly used in the earth sciences for the distribution of data especially multi-level, gridded fields e.g. geopotential height at 1000, 850, 500 and 200 hPa. It has the advantage of being platform-independent (unlike other binary formats like our internal conmap format). There are a multitude of packages which can process NetCDF data e.g. GrADS, Matlab, NCO.

The program `read_nc2cmp` may be used to read common NetCDF files such as those encountered with the reanalysis data. See Part 3 for more information.

Panoply

This is a useful free program from NASA for plotting NetCDF files. Currently there is a problem running it on our UNIX network. However it is also available for Windows and Mac OS X. It is a Java application and requires Java runtime 1.4 or higher.

See: <http://www.giss.nasa.gov/tools/panoply/>

readcmp

A program that produces a text listing of a CMP (conmap) file.

For usage: `readcmp`

Usage: `readcmp [-F fmt][-o outputfile] cmpfile`

Options:

`F`: Fortran format for listing e.g. `'(F10.4)'`

`o`: Output listing file

Examples

(1) `readcmp -F '(F10.4)' pmsl.cmp`

The dump (listing) of the CMP file (`pmsl.cmp`) appears on the screen; you could pipe it or redirect e.g. `readcmp ... | more` or `readcmp ... >! dump.txt`

(2) `readcmp -F '(F10.4)' -o dump.txt pmsl.cmp`

The dump is written to `dump.txt`.

readgribn7

This is used in conjunction with `wgrib` to decode GRIB data files to CMP (conmap) format.

For usage: `readgribn7`

See Part3 for more information.

read_nc2cmp

This is used to decode common NetCDF data files, such as those available from reanalysis products, to CMP (conmap) format.

For usage: `read_nc2cmp`

See Part3 for more information.

splitcon

This program is useful for extracting a particular map from a concatenated (multi-map) CMP (conmap) file. The output map is written to a separate CMP file. By default all maps are extracted, each to a separate CMP file. These individual maps may be processed by various user programs.

`splitcon` may also be used to list the conmap headers in a CMP file as well as dump (list) the contents of a particular map (this dump is not as compact as `readcmp`). The program is intended for several purposes so there are a number of options. The program can extract a maximum of 1500 maps at 1 degree resolution.

For usage: `splitcon`

Usage: `splitcon [-b base][-d][-h][-L][-l][-m mapno] [-n] concat_CMPfile`

Options:

- b: base - basename for output maps i.e. base.0001 etc (default: split)
- 4: when used with `-n` use 4 digit time (default: 2 digits)
- d: when used with `-m` the output file is `def.cmp`
- h: when used with `-m` prints conmap to `dump.lis`
- L: prints list of maps and conmap (CMP) headers
- l: when used with `-n` the output file is in lowercase (default: preserve case)
- m: mapno - map number to output (default: all)
- n: Construct name from header (default: see `-b`)

Examples

For purposes of illustration we will consider the extraction of 5 maps from a NetCDF file called `slp.2004.nc` containing mean sea level pressure for 2004. The NetCDF file is decoded with `read_nc2cmp` (see Part 3 for more information). The maps are saved as the concatenated CMP file called `test.cmp`. Note that `-s 0.01` converts Pa to hPa (mb) and `-m 5` decodes the first 5 maps. We then use `splitcon` to extract maps from

test.cmp to separate CMP files. A suitable command to create test.cmp is:

```
read_nc2cmp -i slp.2004.nc -o test.cmp -d "lon,lat,time" -v PMSL
-u slp -U "'MB'" -r NCEP -s 0.01 -m 5
```

Now we use `splitcon` to extract all of the maps in test.cmp:

```
splitcon test.cmp
```

This will extract all maps from test.cmp. They are given the default filenames split.0001 - split.0005 and are in CMP format.

A list of maps in the concatenated file is given by:

```
splitcon -L test.cmp
```

```
splitcon -L test.cmp >! j.lis    (to redirect the screen output to a file called j.lis)
```

This produces the listing:

```
  1 PMSL                NCEP      20040101 0000    MB
2.5x2.5DEG
  2 PMSL                NCEP      20040101 0600    MB
2.5x2.5DEG
  3 PMSL                NCEP      20040101 1200    MB
2.5x2.5DEG
  4 PMSL                NCEP      20040101 1800    MB
2.5x2.5DEG
  5 PMSL                NCEP      20040102 0000    MB
2.5x2.5DEG
```

```
No. of conmap files:  5
```

The following examples extract a particular map (the third).

This will extract the third map to split.0003.

```
splitcon -m 3 test.cmp
```

This will extract the third map to def.cmp (a default file).

```
splitcon -m 3 -d test.cmp
```

This will extract the third map to a file whose name is based on the contents of the 80

character conmap (CMP) header.

```
splitcon -m 3 -n test.cmp
```

In many cases this is designed to have an 8 character variable name e.g. PMSL, a 5 character identifier e.g. NCEP and a date-time in particular locations of the header. Hence in this particular case the output file is PMSL.NCEP.2004010112.cmp.

This is similar to the previous example except the output name is forced to be lowercase.

```
splitcon -m 3 -n -l test.cmp
```

Hence the output file is pmsl.ncep.2004010112.cmp.

This will create a default file called dump.lis (text format) showing the contents of the third map.

```
splitcon -m 3 -h -d test.cmp
```

It is best to use the `-d` option so that `def.cmp` is created since this is intended to be 'disposable'. The file `dump.lis` shows the conmap header, longitudes, latitudes and data values at each grid point.

To see the contents of a single map CMP file e.g. `pmsl.ncep.2004010112.cmp`, use:

```
splitcon -m 3 -h -d pmsl.ncep.2004010112.cmp
```

and inspect `dump.lis`. Alternatively:

```
readcmp -F '(F10.4)' -o dump.txt pmsl.ncep.2004010112.cmp
```

To extract all maps omit the `-m` option:

```
splitcon -n -l test.cmp
```

In this case all 5 maps will be extracted to the files:

```
pmsl.ncep.2004010100.cmp pmsl.ncep.2004010106.cmp  
pmsl.ncep.2004010112.cmp pmsl.ncep.2004010118.cmp  
pmsl.ncep.2004010200.cmp
```

If you want filenames of the form `prefix.nnnn` then use the `-b` option:

```
splitcon -b Pressure test.cmp
```

which creates the files `Pressure.0001`, ..., `Pressure.0005`.

Also,

```
splitcon -m 3 -b Pressure test.cmp
```

would simply create Pressure.0003.

wgrib

Usage: wgrib [gribfile] [options]

Documentation: <http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html>

A brief help screen is given by: wgrib

See Part 3 for more information.

xconv

This is a free utility that converts GRIB files to NetCDF. It has the particularly useful feature of being able to convert a reduced Gaussian grid such as N80 to a full (regular) grid. The program has an X Windows (graphical) interface. It is not available for Windows or the Mac. See Part 3 for more information.

Usage: xconv

Documentation: <http://www.met.rdg.ac.uk/~jeff/xconv/>

xmgr

This is a free general graphics package that is often used as the ‘graphics engine’ for other free software e.g. SSA. It is supposed to have some NetCDF support. The program has an X Windows (graphical) interface. There is a version for the PC that runs in the Cygwin environment. Some people have found this software to be useful.

Usage: xmgr

Documentation: <http://www.earthsci.unimelb.edu.au/~kevin/xmgr-doc.dir/xmgr.html>