Conversion and quality control of the ECHAM4/OPYC3 GSDIO data to the netCDF format and a brief introduction to Ferret

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Contents

saragasso1% telnet autumn
login: ferret
Password: Ferr5et

version. The command line version (omit this flag) is usually more stable.

1 Introduction

The data from Max-Planck Institute of Meteorology's coupled global climate model, ECHAM4/OPYC3, GSDIO integration were converted from GRIB format (**?**) to UNIDATA's netCDF format (**?**) in order to facilitate easier access to the data. Although there are analytical packages that can deal with the GRIB data such as GrADS, netCDF is by far more user-friendly and belongs to a newer data format generation. NetCDF is in the author's opinion, far superior to GRIB in terms of usability. There are furthermore more applications which can deal with the netCDF format, and the netCDF format is much better documented.

The main purpose of this brief report is to serve as a documentation of the conversion program grib2ncdf.sh, and ascertain that the conversion process has been correct. However, the report will also try to convey to the reader the ease and efficiency of working with the netCDF and the NOAA's Ferret (**?**) graphics package. The quality control described here is by no means exhaustive, but is only meant to give a rough reassurance that the model data are realistic. This report also aims to give an brief overview over main features of the model data.

2 Data and Methods

The quality control was applied to the netCDF (http://www.unidata.ucar.edu/staff/russ/netcdf) files using an freeware application from NOAA/PMEL called Ferret (http://www.pmel.noaa.gov/ferre
This application is a straight forward and easy to use, and minimises the chances of making mistakes. Furthermore, Ferret is quick to use and produces elegant plots (all plots in this report are produced by Ferret). Ferret can be run from the Linux box called autumn, however, it is important that the program is run under the correct shell environment (csh, bash), and that the initial set up (paths) is correct:

The Linux-version of Ferret is more stable than the SGI version.

Several scripts were written in order to produce these plots, and these constitutes the main analysis behind this crude data control, and all such scripts have the suffix ".jnl". All the netCDF files have the suffix ".nc".

rdgrib 22723_code151_100-290 mpi-gsdio-slp.nc ¿ test_slp

saragasso 116-rw-r–r– 1 kareb klima 37735488 Sep 24 08:09 22723_code141_100-290
-rw-r–r– 1 kareb klima 37562792 Sep 24 08:13 mpi-gsdio-snow.nc

The conversion was done with a FORTRAN program called grib2ncdf.sh, developed by R.E. Benestad at the Norwegian Met. Inst. (DNMI). Part of the code was based on a script obtained from Ole Vignes (DNMI). The program assumes that both the GRIB and the netCDF FORTRAN libraries are installed. The FORTRAN routines called from this script are: readgrd.f, cr_ncdf.f, ad_ncdf.f, checkncdf.f, str2int.f, and convert.f. The code is located on saragasso, under directory /usr/people/kareb/data/mpi. The script produces an executable called, rdgrib. This executable is run using the following syntax: i.e.

where 22723_code151_100-290 is the name of the GRIB file containing the GRIB parameter 151 (SLP) and mpi-gsdio-slp.nc is the name of the netCDF file to be created. If this netCDF file already exists, then the code may terminate or do other strange things (The best thing is to ensure that the netCDF file does not exist before running rdgrib). The netCDF files take approximately as much space as the GRIB files:

When compressed (gzipped), the netCDF files size is of the order 8Mb.

A listing of these FORTRAN codes are given in the appendix. The conversion program produces text output, or a transcript, which can be used for checking the conversion process. These transcripts are stored in test_t0, test_t2, test_slp, etc. (stored as compressed, gzipped, files, with extension ".gz.") The files converted are listed in column 1 of table 2:

The data are stored as integer*2 to save space, but with a scale factor and offset in order to reconstruct the real value. Ferret automatically reconstructs the real value, although with some loss of some precision (digits). The precision of the various data files is shown in the third column in Ta-

File name	Variable	Precision
mpi-gsdio-t0.nc	Surface temperatures	0.01oC
mpi-gsdio-t2.nc	2-meter temperatures	0.01oC
mpi-gsdio-slp.nc	Sea level pressure (SLP)	1Pa
mpi-gsdio-lprecip.nc	Large scale precipitation.	
mpi-gsdio-cprecip.nc	Convective precipitation.	
mpi-gsdio-snow.nc	Snow.	1mm?

Ferret command	Comment/description
use mpi-gsdio-t0.nc	Specify which data file to use
set mode meta	Set mode metafile for producing hard copy
sha t0[l=@ave]	sha=short for shade. This command produces fig. 1
go land	Overlay the land contours.

sho dat	Short for show data (not necessary for plotting)
name	title I J K L
T0	surface temperatures (grib 169) 1:128 1:64 ... 1:2292

ble 1. The Matlab script, ncread.m, developed at DNMI by R.E. Benestad also does the reconstruction of these values. Manual recalculation is done according to: Xreal = Scale_factor × Xinteger + Offset.

There is no need for any additional files (such as for GrADS, which needs two additional files) for Ferret to read the netCDF files or produce plots. An example of one Ferret script is chk_t01.jnl:

The command sho dat can be used for looking at the data names and dimension. The output to the screen is typically:

Thus, file mpi-gsdio-t0.nc contains a variable called T0 which has the dimensions 128x64x2292 (lon-lat-time).

Using Ferret to extract data sub-domains It is very straightforward to extract subregions or re-grid the data with Ferret. The process only takes a few seconds:

For re-gridding, the code looks like:

The new grid is 40oW-40oE, 50oN-80oN, and the time axis is the same as before, but only for the interval specified in the second line: 01-Jan-1950 to 31-Dec-2000. Results

Figures 1 to 10 show a selection of plots made with Ferret to give a quick view of what the netCDF files look like. The first figure shows the global temporal mean surface temperatures, and it is evident that the land-sea contrasts follow the coast lines specified by the grid (the topography is given by Ferret). The temperatures look OK, with warmer climate near the equator, the west Pacific warm pool, and cool mountain and polar climates. Figure 2 shows a time series (Hovmuller diagram) of the zonal mean temperatures. Figure 3a shows the global mean temperatures whereas figure 3b shows interpolated temperatures at 5oE-60oN (Which roughly corresponds to Bergen,

use mpi-gsdio-to.nc	opens the file with t0
set region/x=90W:90E/y=30N:90N	selects the region 90W-90E/30N-90N
save/file=extract.nc t0	saves the extract of t0 to extract.nc

```
use mpi-gsdio-to.nc
set region/x=40W:40E/y=50N:80N/t="01-Jan-1950":"31-Dec-2000"
define axis/x=40W:40E:0.5 nyx
define axis/y=50N:80N:0.5 nyy
define grid/like=t0/x=nyx/y=nyy/t=nyt nyg
save/file=regridded.nc t0[g=nyg]
```

Norway). The heavy solid lines show the low-pass filtered temperatures using a 121-month Hanning filter. Ferret automatically computes area mean (of grid boxes) averages, giving less weight to higher latitudes. A annual cycle is visible in the global mean temperatures, and a rapid global warming is evident after 1960. Figure 4 shows a spatial map of the temporal mean time derivatives, or the mean trend, of the surface temperatures between 1860-2050. The only negative trends are found in Antarctica. The fastest warming is found over the Kara Sea and Hudson Bay, but also over Finland and eastern Russia.

The temporal mean 2-meter temperatures seen from space are shown in figure 5 (orthographic projection). The map is very similar to figure 1, but is presented with a different projection. Figure 6 shows a Hovmuller diagram of the 2-meter temperatures, and is very similar to figure 2. The mean trends over 1860-2050 and 1960-2050 are presented in figure 7a and b respectively. A strengthening is seen in the warming over the Hudson Bay region whereas the warming over the Kara Sea diminishes after 1960.

Figure 8 shows a map of the temporal mean SLP, suggesting reasonably sensible values. The permanent low pressure regions over Antarctica, the North Atlantic (Iceland) and the North Pacific are visible. The Antarctic SLP is on average substantially lower than elsewhere. Figure 9 shows a Hovmuller diagram of the zonal mean SLPs.

Figure 10 shows the mean snow conditions. For some reason, there is not much snow over the interior of Greenland. There is one "hot spot" with about 10 times as much snow as elsewhere in the Himalayas. The units in this data set are given as mm, however, it is not certain if this is true. There is a possibility that the units are in meters instead. Part of the problem is the lack of information supplied with the GRIB files and lack of proper documentation. The conversion of the large scale and convective precipitation (grib code 142) was unsuccessful as all the data were zero. A closer inspection revealed that the real data array returned from the subroutine held only zeros after the call to rdgrib. Further effort will be spent dealing with these files and the geopotential heights in the future.

3 Conclusions

The preliminary analysis carried out here show that the conversion from GRIB to netCDF did not distort the data. However, there were some preliminary problems reading the precipitation data. It is not certain whether the snow data is correct and that the correct units have been used. More information about the precipitation and snow files will be sought before further attempt to convert these.

4 Acknowledgement

This work has been possible through the use of Ferret and netCDF, and I wish to thank the people who have been involved in the making of these packages; they have made life much easier for me so I can focus on the science instead of having to spend huge efforts on pre-processing, testing, and coding.

Figure 1. Map over mean surface temperatures from the entire GSDIO run.

Figure 2. Time series plot, or a Hovmuller diagram, of the zonal mean surface temperatures.

Figure 3a. Plot of the global mean surface temperature time evolution.

Figure 3b. Plot of the 5oE-60oN surface temperature time evolution.

Figure 4. Map showing the global mean surface warming trends in (oC/decade)

Figure 6. Similar as Figure 2, but for the 2-meter temperatures.

Figure 5. Satellite view of the mean 2-meter temperatures.

Figure 7a. Satellite view of the mean 2-meter temperature trends

Figure 7a. Satellite view of the mean 2-meter temperature trends for the interval 1960- 2100.

Figure 8. Map showing the permanent sea level pressure systems (SLP).

Figure 9. Similar as Figure 2, but for the sea level pressure.

Figure 10. Map showing the mean snow conditions.

Figure 11. Map over the mean geographical large scale precipitation patterns.

Figure 12. Map over the mean geographical convective precipitation patterns.