Software package description *cube_mseed*

1. Introduction

The CUBE data logger acquires continuously analog data, digitizes it and periodically, depending on the CUBE setup, assigns high-precision timing information to data samples. Both, the data, the timing/positioning and optionally auxiliary information form a continuous binary data stream which is written into daily segmented files to the internal memory card. After downloading the data from the CUBE it needs to be converted to standard seismic formats, i.e. Mini-SEED, SEGY, etc. Two different software packages are provided to perform the data conversion. The *gipptools* package (download from http://www.gfz-potsdam.de/forschung/ueberblick/departments/department-2/geophysikalische-tiefensondierung/servicesinfrastruktur/geophysikalischer-geraetepool-potsdam-gipp/software/gipptools/) was mainly designed to cut out time windows (window or event oriented processing) from the CUBE data streams and convert segments (time series windows) to Mini-SEED or SEGY formats. The tools can be used, for instance, to cut out and convert known time windows, i.e. shots, blasts, earthquakes, etc.
The main purpose of the package *cube_mseed* is the conversion of complete CUBE data streams to Mini-SEED. The conversion produces hourly segmented Mini-SEED files, which then can be used for further data processing (for instance ambient noise analysis, any processing requiring long time series, etc.). The *cube_mseed* package is intended to complement the *gipptools* package.

2. Installation requirements

The *cube_mseed* package runs exclusively on a Linux platform. It was successfully developed, tested and used, as an example, on a PC running Linux 3.2.0-0.bpo.4-amd64 #1 SMP Debian 3.2.46-1+deb7u1~bpo60+1 x86_64 GNU/Linux (from uname -a).

3. **Where to get the package**

First get the *qlib2* library from http://www.ncedc.org/qug/software/ucb/. I used version qlib2.2012.347.tar.gz. Then get the *cube_mseed* package from www.omnirecs.de/XXX,

4. Installation

Unzip and untar the *qlib2* download.
Go to the *qlib* directory
Type : make clean
then: make all64

If problems occur, you might configure/modify/adjust the *qlib2* Makefile.

Untar the *cube_mseed file,* go to the *cube_mseed* directory and compile the package by typing "make" . No special configuration is generally needed.

5. How to use

Assuming, for instance, a tcsh Unix shell and the presence of all executables in the working directory, and let 03291144.151 a CUBE sample file.

- to convert a single CUBE file to Mini-SEED
cube_merge_mc 03291144.151 | *pcube2asc_mc | add_time_mc | resamp_mc | asc2mseed_m c -v*
Note: you might want to drop the -v option for asc2mseed_m c to reduce output on screen.

- to convert a set of daily CUBE files from a single CUBE having correct file creation times
cube_merge_mc `ls -tr /path_to_data/????????.??? ` | *pcube2asc_mc | add_time_mc | resamp_mc | asc2mseed_mc -v*

Make sure that the CUBE data files represent a data stream are from a single CUBE and are in chronological order with no g aps!

If you want to convert entire or larger data sets from several CUBEs automatically, have a look at the provided scripts *conv_files.sh* (Bourne shell) or *conv_mfiles* (tcsh shell). These scripts sort CUBE files, exclude very small CUBE files (without useful data), check if they are suitable to be merged, do the actual conversion and write log files. Some adjustments of those scripts might be necessary.

For unconventional CUBE usage or problematic CUBE data streams, you might want to use the -s or -m option with *pcube2asc_mc,* see 7. Options,...

6. Options, Warnings & Error messages

To avoid glitches caused by the built-in CUBE GPS receiver, a very conservative evaluation of the GPS fixes in the data stream is done. For CUBE installation scenarios like under water, in buildings, in tunnels, etc. or otherwise very poor GPS reception (less then one valid GPS timing fix a day) several options can be used to "relax" the conservative rules.

pcube2asc_mc -m : allows the data stream to be converted to Mini-SEED when a CUBE has been moved significantly while in acquisition (what you should not have done anyway!)

pcube2asc_mc -s : allows the data stream to be converted to Mini-SEED when a CUBE has extremly poor GPS reception, i.e. whith gaps between GPS fixes of more than one days. This mode should be used when the CUBE gets only GPS reception at the beginning of operation, runs several days or weeks without GPS reception and, finally, gets GPS reception just before being stopped. An installation in an Ocean Bottom Seismometer system or temporary installation inside a building/tunnel or otherwise "GPS free zone" would be a typical application.

These options might introduce small timing errors (a few ms), so **don't used** them as standard options!

During data conversion warnings might occur frequently, they can be ignored. They might be useful for problematic CUBEs, i.e. which behave not normally (hardware problems, long losses of GPS reception, etc).
Error messages indicate serious CUBE problems, mostly for instance corrupted files, data streams. Reasons for this could be : defect CUBEs, file system corruptions on CUBE memory card which can be fixed by formatting the CUBE data memory card.

The conversion package needs substantial amounts of core memory on the computer. Error messages (independent on the CUBE files) might occur if resources are not sufficient. To fix this, decrease MXSMP in cube.h, recompile and re-run the software. Generally, a computer with >8GB core memory is advisable to run the conversion.

7. IMPORTANT INFORMATION

1. Cube data will be convertable only after a few minutes after the CUBE was powered up.
2. When you remove/switch off cubes with cycled GPS, remember that you want to w ait at least GPS_OF minutes to get timing information after the last event (shot, blast, quake, etc.) before shutting down the CUBE
3. If you use vertical component geophones, place them at least 10 cm away from the cube
4. If you run the CUBE in a setup where you have GPS reception only in the beginning and at the end of data acquisition (under water, in tunnels/buildings, etc.) use "pcube2asc_mc -s". Remember to let the CUBE "see" open sky (=GPS reception) at least several minutes at start and before shutting it down.

8. What is *cube_mseed* doing

The *cube_mseed* package consists of several software modules which communicate data via UNIX pipes. It uses Mini-SEED library *qlib2* of Doug Neuhauser, (doug@seismo.berkeley.edu).

- *cube_merge_mc* merges multiple CUBE files into one data stream. Some checking if data files actually can be merged is done.
- *pcube2asc_mc* converts the data stream to ASCII, checks according to an extensive list of conditions if a GPS fix (location and time) is suitable to be used for timing purposes. **Important:** The module also strips off data before the first and the last suitable GPS fix. It separates and dumps data from auxiliary channel(s).
- *add_time_mc* adds timing information to all data samples by interpolating between samples with GPS provided timing
- *resamp_mc* conducts a simple "fractional delay filtering", i.e. resamples the data samples in such a way that the data stream starts at a "full" second. By doing this, originally asynchronously recording CUBES will be synchronized. This resampling is done by a sinc interpolation between samples.
- *asc2mseed_mc* splits the data into hourly segments, demultiplexes the individual channels

and converts the data to Mini-SEED.

get_cube_fileno_mc is a small tool to get the sequential CUBE file number.

9. Contact

In case of problems, suggestion, etc. please contact Trond Ryberg via e-mail:

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