# Notes on the real-time and delayed-time processing of the UK-OSNAP microcat data

→ calibration of the instruments is essential to obtain accurate measurements and minimize errors in the transport calculation

→ calibration data obtain for each moored CTD during intercalibration cast: Each moored CTD is attached to a shipboard CTD rosette frame and a deep cast is carried out prior to deployment and after the recovery of the moored instruments. During the cast, 12 bottle stops of 5 mins each are performed, from the bottom to the surface, in order to cover the different range of pressure of the moored instruments. The comparison with the 1Hz-bin averaged shipboard CTD data gives calibration coefficients for each sensor (T, C, P) on each moored instrument.

Outline of the processing stages:

- Initial processing setup: creation of a data processing metadata control file.

- Raw data downloading and archiving

- Conversion from instrument format to standard Rapid Data Base (RDB) format

- Trimming of data record, basic statistics and summary plots

- Calibrating and quality control of the moored CTD data:

- Gridding of the data: creation of a lowpass filtered, regular gridded data set

**NOTE: the OSNAP data structure separates executable scripts (*osnap/exec/…*) from output files (*osnap/data/moor/…*). For clarity, file extensions for scripts are coloured red, input files are coloured blue, and output files are coloured green. The output files of some scripts may become the input of a later script. Hopefully this will make navigation of this document a little easier.**

### A word on git

Users of the osnap mooring processing toolbox should request a new branch from the latest post cruise updated master from <https://github.com/lhoupert/m_moorproc_toolbox>. This should be the last working version used and updated since the last mooring cruise and the branch should be renamed to reflect the upcoming cruise. A copy of this branch should be physically taken on the ship (i.e. *osnap/exec/$cruise/*). The data (archived from previous cruise) is not kept on git and effort should be made to make sure that the most recent version (i.e. from SAMS servers) is copied prior to the cruise/processing. Once the cruise is complete the branch should be compared and merged back towards the master and should be well commented to capture significant changes made to the code.

### Set up directory structure

#### Processing scripts:

a) If it doesn’t exist, create a directory *delayed\_processing\_script* in *osnap/exec/$cruise/* (from the previous cruise)

#### Shipboard calibration files

##### Cruise ctd files (pre and post deployment)

a) Create the directory for the cruise data: *osnap/cruise\_data/$cruise*

b) Copy the cruise data from the archive directory of the cruise data (e.g. M:\Mar\_Phys\Cruises\DY078\_079) ; Look at the previous year cruise to copy the same type of ctd files ( \*\_1hz.nc, \*.ros and \*\_align\_ctm.cnv) for each caldip cast. The number of the caldip cast can be found in the cruise report or in *osnap\data\moor\proc\_calib\dy078\cal\_dip (cast\*info.dat).*

##### Microcat caldip data

a) create a *cast???info.dat* file in *osnap/data/moor/proc\_calib/$cruise/cal\_dip/* for each caldip that summarizes informations about each caldip CTD cast (location, time) and the serial numbers and the deployment periods of the lowered microcats. The deployment period number is used later (part 6b) to create a metadata file of the mooring deployed during the deployment period.

b) create the directories that will host the raw microcat data files for each CTD cast, *osnap/data/moor/raw/$cruise/microcat\_cal\_dip/cast???/* (where *???* is the cast number), and move in this directory the raw data file (.hex, .cnv, .xml, .xmlcon, etc..)

#### Microcat deployment files

a) creation of a data processing control file *$moorname$info.dat*  for each mooring in the directory *osnap/data/moor/proc/$moorname$*. The *$moorname$info.dat* file contains metadata for mooring position (lon, lat, waterdepth and mean magnetic deviation during the deployment), deployment period, nominal depths and serial numbers of each instrument. \*see previous cruise folder for an example.

b) copy the raw SBE37 files (with .cnv files) in the directory *osnap/data/moor/raw/$cruise/microcat/.* If the raw .cnv files are not named as *$serialnumber\_data.cnv*, rename them.

#### Start and Set-up Matlab

a) Open in a terminal and go in the root mooring processing directory (e.g.: *OSNAP\_mooring\_data\_processing/osnap/* ). Check that in the top of the *startup.m* file a “cd” command is sending you in the cruise directory you want to process (e.g. *cd exec/pe400*). Once matlab started under the *osnap/* directory the *startup.m* file should move you in the cruise directory you are interested in. In the cruise directory *osnap/exec/$cruise/*, another *startup.m* file should be present, generating the different path related to the cruise data.

### Processing of the moored microcat

a) Stage 1: Edit (paths to the data, mooring name, year of the first measurement) and run the script *osnap/exec/$cruise/stage1/microcat/mc\_call\_2\_$cruise.m* : convert the raw data to RDB formatted file .raw for an entire mooring. The processed data are stored in *osnap/data/moor/proc/$moor/microcat/*

b) Stage 2: Check that the deployment time and recovery time are accurate in the corresponding *$osnap/data/moor/proc/$moor/moor\_info.dat* file, then edit and run *osnap/exec/$cruise/ stage2/microcat/microcat\_raw2use\_003\_with\_ODO.m* . This script generates *.use* files (launching and recovery period removed) in *osnap/data/moor/proc/$moor/microcat/* . The script also creates data overview sheet including basic statistics, and produces summary plots, including 2-day low-pass plots.

### Lowered microcat processing after the shipboard calibration casts

The script *osnap/exec/$cruise/stage1/microcat/mc\_call\_caldip\_v4b.m* loads: i) the raw microcat data located in *osnap/data/moor/raw/$cruise/microcat\_cal\_dip/$castnber/* , ii)the shipboard CTD data *(if new calibrated ctd files are available after the cruise, the \*\_raw.nc and \*\_psal.nc have to be replaced)* files for the *$castnber* ( in *osnap/data/$cruise/)*, iii) the caldip metadata file *castnnninfo.dat* file located in *osnap/data/moor/proc\_calib/$cruise/cal\_dip/*.

The script writes to a directory *~/osnap/data/moor/proc\_calib/cal\_dip/$cruise/microcat/$castnber/* which is created manually.Plots are generated for all microcat data for one CTD cast with the shipboard CTD data. Note that the raw microcat files have to be named as *serialnumber\_cal\_dip\_data.cnv*.

The script *osnap/exec/$**cruise/stage1/microcat/mc\_caldip\_check\_$cruise.m* provides a quick quantitative comparison of Microcat cal-dip data with the SBE911 data from the CTD. Data obtained at the deepest bottle stops are used. For each instrument differences of conductivity, temperature and pressure between the instrument and the CTD sensor were calculated. The mean and standard deviation of the differences for each instrument are then presented in a tablein  *~/osnap/data/moor/proc\_calib/cal\_dip/$cruise/microcat/$castnber$/microcat\_check$castnber$.log*

### Delayed mode processing of the microcat data

#### Set-up metadata files

Manually add entries in two metadatabases: *cruise\_id.xls* lists the cruise id and unique number identifier; *microcat\_calib\_cruise.csv* lists the mooring name, the associated deployment and recovery cruises number. The metadata files are under *osnap/data/moor/cal\_coef/*

#### Calculation of accurate nominal depth of the mooring instruments, update of the metadata files

a) If there are large differences between the planned instrument depth and the actual depth for most of the deployment (due to trawling etc), it is possible to calculate this from the observed pressures. Generally, we have not needed to do this stage but the following might be useful. Note this just updates the ‘nominal depth’ which is used for metadata and file organisation, but will not impact the final data product. The gridding algorithm pulls info directly from the pressure record for example. Run the function *ctd\_instrdpth2.m* for each mooring. This will calculate accurate instrument depth from pressure record and update the *info.dat* file located in *osnap/data/moor/proc/$mooring/*

b) Manual creation of a *osnap/data/moor/cal\_coef/osnapXX\_deploymentdepths.dat* file, which lists all the instruments on every mooring deployed within the deployment period XX (by using the info.dat file for each mooring in *osnap/data/moor/proc/$mooring/* )

#### Calculation of the pre- or post- deployment conductivity and temperature calibration coefficients

o) The raw microcat data files *.raw* have to be generated before starting this process (by doing the step III for example)

a) Before processing the mooring data, the calibration coefficient has to be calculated from the comparison between the calibrated shipboard CTD and the lowered mooring CTDs, this task is achieved by running the script *osnap/exec/$cruise/delayed\_processing\_script/mcat\_final\_calibration/*

*caldip\_coefficient\_calculation.m*. Several user parameters have to be edit in the beginning of the

*caldip\_coefficient\_calculation.m* script.   
b) Setup the paths to the data files in insitu\_cal\_osnap.m (by adding an entry for the cruise in the if/else part)

c) Run *caldip\_coefficient\_calculation.m* for each caldip cast, the user can adjust the options for the figure at the beginning of the script. The script produces plots and a table of the calibration coefficients in *osnap/data/moor/proc\_calib/$cruise/cal\_dip/microcat/$castnber/.* The calibration coefficients are then manually entered into 3 CSV format database in *osnap/data/moor/cal\_coef/* (*microcat\_cond.csv*, *microcat\_temp.csv* and *microcat\_pres.csv*). This process is quite arduous and ultimately we would like to automate. Note the format used in the csv tables for previous ‘before-after deployment’ cruise pairings and emulate. If you freeze the column and row headings (‘freeze panes’ in Excel) you can keep them visible while manually entering. Triple check!

d) Set-up the scripts that apply the calibration corrections ( in *osnap/exec/$cruise/process/ mcat\_final\_calibration/microcat\_apply\_cal\_plus\_rbr\_idr\_osnap.m*). Particularly:

1) the string formats for the reading of the .csv files has to be edited according to the number of columns in the csv files (variable *strformat* in the header of the script).

2) the reference CTD loaded for the QC plots. The cruises used for the plots are defined by the variable *ctd\_ref\_cruises*, then the user has to edit the end of the script (if/else section) by adding plotting instructions specific to each cruise.

e) Once the script is set-up, *microcat\_apply\_cal\_plus\_rbr\_idr\_osnap.m* applies the calibration coefficients for each time-series and bad data are removed. Constant offsets and conductivity pressure correction are applied if required.

* Average trend is
* General trend: to be applied when pre - or post cruise calibration is missing for individual instruments

The end result of this stage is the processed (but not gridded) microcat data in

*osnap\data\moor\proc\$mooring\microcat.*

Note that, if the script discovers a version of the processed data already exists in this directory, it will copy it, append its creation date and save it as a backup. Therefore the ‘to use’ data file is the one without any date appended, e.g. *rtwb1\_04\_2017\_001.microcat*

#### 3a) Export to oceansites format [if required]

The mooring data are annually submitted to Feili Li (OSNAP) in Oceansites netcdf format. Currently we are generating this format (08/2019) though ultimately it may become BODC’s remit. Loic modified a suite of scripts to do this in *osnap\exec\ar30\export\_Oceansites.*

The top-level script *osnap\exec\ar30\export\_Oceansites\convert\_SAMS\_mooring\_to\_oceansites.m*

sets up directory paths and declares metadata to populate the netcdf file. This script has to be run once per mooring, note the commented out moorings on lines ~26-29. Scan through the script for any other tweaks necessary for the new mooring deployment. This script calls

*osnap\exec\ar30\export\_Oceansites\rodb\_to\_oceansitesnetcdf*

which loads the Microcat and current meter datafiles and converts them to netcdf.

Note: the script searches for known instrument IDs (Microcat = 337 or 335, Nortek = 368 or 370) to populate its arrays. This caused some indexing issues when ODO Microcats (with oxygen sensors) were added to the array for the 04\_2017 mooring. Be aware that some careful checking will be required if another new instrument type is added to the moorings, including (but not limited to) lines ~56 – 83 and 86-98. This also applied to the gridding scripts (stages 4 and 5).

Data and plots are saved to

*osnap\exec\ar30\export\_Oceansites\oceansites\_format*

These tend to be small files which can be emailed as a .zip file or similar.

#### Gridding of the data: creation of a lowpass filtered, regular gridded data set.

*Update the mooring file names and microcat order field in the script \osnap\exec\ar30\stage3\gridding\grid\_osnap\_mcat\_data.m*

Check initialisation parameters listed in that script.

Run the script

It calls the worker script: *hydro\_grid\_osnap\_linear\_interp.m* in the same directory which does the following:

-Load microcat data

-Fill pressure gaps

-Convert conductivity to salinity and despike

-Apply low-pass temporal filter

-Close big gaps in salinity

-Interpolate vertically

-Save and generate plots.

C. Data are saved as a mat file in *~\osnap\data\moor\proc\hydro\_grid\*

The gridded .mat files have the following variable naming conventions using temperature data as an example:

jd\_grid – julian day for ungridded data – 2 hour timesteps. NOTE the JD naming convention – currently the wrong way round!

jd -- julian day for gridded data – interpolated onto 1/2-day timesteps

T -- original stacked Temperature data from the deployments

Tf – Temperature data with temporal filter applied

Tfs – Temperature data with temporal filter, interpolated onto ½ day timesteps

TGfs -- Temperature interpolated onto the pressure grid (p\_grid)

#### 5) merging of the several years of deployment (and if necessary moorings)

First, we have to create 2 .dat files with instrument data from EB1 in one file. The same for WB1 and WB2 combined in the same file. Note, only instruments on WB2 that are at unique depth should be included. Note 2: in the .dat file, the 3rd columns correspond to the position of the mcat in the grid file created in 4) (can be found under *~/osnap/data/moor/proc/hydro\_grid/*

E.g.: *~\osnap\exec\$cruise\stage3\gridding\MCAT\ rtwb\_osnap\_03\_2016.dat*

Info can be found in:

*~\osnap\data\moor\proc\rtwb1\_03\_2016\rtwb1\_03\_2016info.dat*

Second, check and update paths and parameters under SET DIRECTORIES FOR MERGE and MERGE INITIALISATION (e,g, jg\_end and lastyeardata) headers in *grid\_osnap\_mcat\_data.m*

Last, update the scripts *merge\_osnap\_data\_west.m* and *merge\_osnap\_data\_east.m* by copy and pasting the last merge block section. In particular: create a new deployment by copying a previous one; change all the variable name (e.g. for osnap3, changes fileID2 -> fileID3, T2 -> T3, etc…); change the figure and titles (l326-331-336-341); and change concatenation.

Output files are saved in: *~\osnap\data\moor\proc\hydro\_grid\_merged\.*

The gridded and merged .mat files have the following variable naming conventions using temperature data as an example:

JG -- julian day

Tfs -- original stacked Temperature data from the deployments

TGfs -- temperature interpolated onto the pressure grid (PGfs)

#### Export to NetCDF for CLASS data working group

Change the filenames in the script *Export\_moor\_to\_NetCDF,m* to reflect the most recently processed data.

Run *Export\_moor\_to\_NetCDF.m* in *\osnap\exec\ar30\stage3\gridding*