omcat

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Abstract

This document describes how to use the task **omcat** designed to generate a source catalogue from multiple ODF products (produced by the task *omichain*).

1 Instruments/Modes

Instrument	Mode
OM	Imaging

2 Use

pipeline processing	yes
interactive analysis	no

3 Description

This package contains three Perl scripts and one Fortran-90/95 module which ingest the OM observation data (source lists) initially processed with the task *omichain* and combine them into a single output catalogue.

4 Tasks of the omcat package

The location of the products of the OM imaging chain is specified by either indicating with the parameter *inpdirectory* to the folder whether the ODF products are stored or by specifying the file name containing the list of ODF filess in the parameter *odflist*. The task *omcat* will inspect these files and ingest all of the acceptable source lists producing a single catalogue.

Alternatively, the processed ODF files can be placed into a directory with the default name “inp”. The task *omcat* will create a list of ODF folders placed into the directory “inp” and will use this list for processing data in each of the folders.

The format of the output file generated by *omcat* is not yet the final (designed) format of the OM source catalogue (e.g., the IAU source identifiers are missing, and the unique sources numbers are not assigned yet). In order to convert the file into its designed final format there is a task *omcatiau* which would assign the IAU identification names to the catalogue sources and would give the catalogue its final format.

One more task (*omcatlim*) would add 6 columns into the catalague SUMMARY table to indicate the detection limits for each filter of each observation (this step was initially missed from the main processing task *omcat*, but it was simpler to use a separate task for adding extra columns rather then modifying the main task because bulk processing of the OM data was already performed with the original *omcat* task).

So, in order to process the catalagoe and to get it in its almost final format, the processing sequence is the following:

- omcat
- omcatiau
- omcatlim

5 Running the task omcat

In order to run *omcat* the user can type one of the following commands:

1. The simplest way of running *omcat* is to call it by using the command 'omcat' from a home directory where the file containing the list of paths (an ASCII file) to the OM ODFs is located. The default name for this file *odfs.list*.
2. Type the command 'omcat odflist=<ascii-file-name>' to process the OM ODF data from the list of ODF directories specified by the parameter *odflist*.
3. Type the command 'omcat' from a home directory containing a folder with the default name 'inp'. The OM ODFs to be processed are supposed to be inside of this folder 'inp'. Alternatively, the user can specify the name of the input directory with OM ODFs by using the parameter *inpdirectory*: 'omcat inpdirectory=<input-directory-path>'. The output products will be placed into the folder with the default name 'out' (if this folder does not exist, it will be created in the home directory).
4. Use the command 'omcat outdirectory=<output-directory-path> to store the processing products in the specified output folder.

   With the default parameter settings the omcat will process all the ODFs listed in the file *odf.list* located in the current (home) directory or the ODF products placed into the directory with the default name 'inp'. The output data (OM master catalogue) will be stored in the directory 'out', the log files will be stored in the directory 'logs'.

6 Finalising the catalogue format

The task *omcat* can be run many times with different input data, which will be ingested into the OM master catalogue (the master catalogue being growing in size). When all the available OM products are ingested, the master catalogue needs to be formated to its final form, which is done by calling the task *omcatiau* (part of the package *omcat*). Having the default folder structure in the working (home) directory, i.e. the the folders *inp*, *out* and *log*, the task can be started by simply typing:

```
omcatiau prefix=RA
```

from the working directory, where `RA` is the RA-segment identifier ranging from 0^h to 23^h (see below). The task will pick up the master catalogue file with the default name **old_mastercatalogue.fit**, will process it and will generate a temporary file **new_mastercatalogue.fit**, which then will be formatted to its final form having the default name **iaucat.fit**.

The parameter "*prefix*" is designed for the case when the catalogue is generated in the form of multiple FITS files, each corresponding to a different right ascension segments on the sky. Then the source numbers in the column **SRCNUM** will not be unique (they will be repeated in each RA segment). If the value of the parameter *prefix* differs from zero then the source numbers will be expanded by using this value multiplied by 10^7. For example, if the catalogue file corresponds to the RA segment starting from 4^h of right ascensions and the parameter is used in the form "*prefix=4*" then the first source in the file will be assigned a new number 40000001 (which limits the maximal number of sources to $10^6 - 1$ in each of the catalogue files).

The task *omcat* produces the SUMMARY table with missed detection limit columns. To introduce these colums, an extra task (*omcatlim*) was added to the package. This task inserts these columns for each OM filter. The task *omcatlim* takes the catalogue produced by the task *omcatiau* (with the default name *iaucat.fit*) and also takes the same set of ODF products that was initially used by the task *omcat*, extracts the detection limits from the headers of the product source lists and fills in the columns DETLIM_(filter name) in the SUMMARY table of the output catalogue file.

The default name of the output file of the task *omcatlim* is **omcat.fit**, which is the final catalogue product. The simplest way of running the task *omcatlim* is the same as of the task *omcat*, i.e., by simply typing

```
omcatlim
```

being in the working directory that contains the folders *inp*, *out* and *log*.

7 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
inpdirectory	no	string	inp	

Path/name of the input directory containing the list of the ODFs to process or the ODfs themselves.

outdirectory	no	string	out	

Path/name of the output files directory

logdirectory	no	string	logs	

Path/name of the log files directory

odflist	no	string	odf.lost	

Text file containing the list of ODF folders to process

deleteoldcatalogue	no	boolean	no	

Flag for deleting old master catalogue and staring ingesting source lists from scratch

prefix	yes	int	-1	-1 to 23

Prefix number to expand the unique source numbers in the column SRCNUM

8 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

Unable to open the ODF list file *(fatal)*
Problem with the input file: the file could not be opened, probably because it is not located in the directory where **omcat** expected it to be.

Could not allocate memory for : name *(fatal)*
Memory for an array could not be allocated

Failed to release memory for : name *(warning)*

corrective action: Memory for an array could not be deallocated

two sources matched in same OSW *(warning)*
warn user and use nearest source
corrective action:

colExist *(warning)*

corrective action: The source-ID column already exists in one of the input source-list files

9 Input Files

- An ASCII file containing the list of XMM OM ODFs to be processed, each line corresponding to the path of a single ODF.
- OM Imaging-mode source lists (FITS-files) produced by the task *omichain*

10 Output Files

- Two source lists (FITS-files) containing the ingested input sources. The default name for the main output file is **old_mastercatalogue.fit**; the second output file with the default name **new_mastercatalogue.fit** contains the interemdiate results of source-list processing. At the end of the task run, the old master catalogue file is replaced with the newly generated one, so, eventually, both files become identical.
- One formatted final OM source catalogue with the default name **mastercatalogue.fit** which is generated from the file **old_mastercatalogue.fit** by the task *omcatfinal*.

11 Source ingestion routine

The source ingestion is implemented in the task **ommastercatalogue_mod.f90**. This task takes the output source lists from each OSW (filenames listed in input listFile) and combines them to form the whole-observation source list (outFile), which is the pipeline deliverable product OM observation source list. The OSW source lists will previously have been magnitude calibrated (in the instrumental system, task ommag) and have RA-DEC coordinates (task omatt)

This primarily involves identifying which source is which in each list, combining the positions from each pass-band/exposure to give a best estimate and a refined error, and calculating the optical/UV colours for those sources observed with multiple filters in both the instrumental and standard systems. The magnitudes in the OSW source lists are in the instrumental (natural) system, and a call to the CAL extracts the current colour transformation matrix, which is applied to the instrumental magnitudes to give magnitudes in the standard system. Other information (e.g. quality flags) is also propagated.

A new column (SRC-ID) is added to each OSW source list, containing the observation source list number for the OSW source.

The combined source list is sorted into ascending Right-Ascension order. For sources in a particular filter that the program has identified as being identical (using the parameter nsigma and the position errors of the sources), the average magnitude of the sources is computed from the averaged corrected count-rates, **using equal weights**.

12 Instrumental (Vega) Magnitudes and Colours

The tabulated magnitudes are those that have been computed by the task *ommag* called within the OM imaging-mode processing chain (*omichain*). The task *omsrclistcomb* gave the averaged magnitudes for the sources that it considers to be the identical. The task *omsrclistcomb* uses a colour table that it loops through to see if the relevant instrumental magnitudes (one of U, B, V, UVW2, UVW1 and UVM2) are present for the calculation of the instrumental colour. The colour list is :-U-B, B-V, U-V, UVW2-UVW1, UVW2-UVM2, UVM2-UVW1, UVW2-U, UVW2-B, UVM2-U, UVM2-B, UVM2-V, UVW1-U, UVW1-B, UVW1-V

13 AB Magnitudes and Fluxes

AB magnitudes (see Oke, J.B. 1974, ApJS, 27, 21) and fluxes are given for each filter ($in\ units\ of\ ergssec^{-1}cm^{-2}\mathring{A}^{-1}$)

In the header of the table the keywords **ABM0X, ABF0X and E2JYX** are given for each filter (where X is a filter). The keywords give the AB magnitude zero-point, the conversion factor from count-rate to AB flux and the conversion factor from flux to Janskys, respectively. The first two values are obtained from the **OM calibration** files.

14 The SRCLIST table

This table will contain astrometric, photometric, source-parameterisation and source-flagging parameters. The number of columns will depend on the number of different filters that are present from the input source-list files.

The following sections describe the individual columns in the table.

14.1 IAUNAME

The individual unique name of a source in SOURCES the table in the format of `XMMOM JHHMMSS.S+/-ddmmss`, where J means that the catalogue source coordinated have the epoch of J2000; HHMMSS.S – hours, minutes, seconds and decimal fraction of seconds or the source Right Ascension; ddmmss – degrees, arcminutes and arcseconds of the Declination coordinate.

14.2 N_SUMMARY

The number linking the table SOURCES with the table SUMMARY and giving the entry number in the table SUMMARY corresponding to the observation parameters of the the OBSID to which belongs the source.

14.3 OBSID

The unique XMM observation identification number.

14.4 SRCID

This column is a reference number that enables any source in an input source-list file to be identified as one of the input sources that was "merged" to make that source. (**omsrclistcomb** adds a column **SRCID** to each input source-list file.)

14.5 SRCNUM

The unique source number in the present OM source catalogue.

14.6 FILTER_SRCDIST

The distance to the nearest source (in arcseconds).

14.7 RA and DEC

These columns will contain the **Right Ascension** and **Declination** (**J2000**) of each **merged** source. If the parameter alignaxes was set to **true** (default) then the **RA** and **Dec** coordinates of each of the individual sources that constitute a merged source may have small corrections added.

All the entries in the table will be in order of increasing RA value.

14.8 RA_HMS and DEC_DMS

The Right Ascension and Declination given in the form of hours-minutes-seconds and degrees-arcminutes-arcseconds.

14.9 POSERR

This column contains the standard error of the merged source position- ie $(1/n)\sqrt{\sum_{k=1}^{n} err_k^2}$, where err_k are the position errors of the n individual sources.

14.10 LII and BII

These two columns contain the **Galactic longitude** and **Galactic latitude** computed from the **RA_CORR** and **DEC_CORR** columns if present, otherwise from the **RA** and **DEC** columns.

14.11 N_OBSID

The number of OBSIDs in which the source was observed (a source might have multiple entires in the SOURCES table, each entry corresponding to a different observation with its own OBSID number.

14.12 FILTER_EXP

Summed exposure times for each filter within a single observation (OBSID).

14.13 FILTER_SIGNIF

The source significances (signal-to-noise) for each OM filter. These values are the averaged values from the individual sources that were merged into a source. The significance is set to the negative of its value if the averaged corrected count-rate exceeds 1000 count per second and all the magnitudes will be set to null.

14.14 FILTER_RAW_RATE

There exists one **_RAW_RATE** column for each filter. They are populated by the unweighted mean raw count-rate of matched sources in units of counts/sec. These columns are required by the task **ommergelists**. Consequently, the **FILTER_RAW_RATE** columns will only be created in the output table if the input sources have been detected from mosaiced sky-images.

14.15 FILTER_RATE_ERR

For each filter there is a column for the source corrected count-rate errors. These values are the standard errors computed from

$(1/n)\sqrt{\sum_{k=1}^{n} err_k^2}$, where err_k are the corrected count-rate errors of the n individual sources.

14.16 FILTERS_INS

Depending on what instrumental magnitudes are present, there will be various colours obtained from the instrumental magnitudes.

14.17 FILTERS_INS_ERR

The errors in the instrumental computed are computed from the formula $\sqrt{err_1^2 + err_2^2}$, where err_1 and err_2 are the errors in the two instrumental magnitudes.

14.18 FILTER_AB_MAG

For each filter there is a column for the source AB magnitudes. These values are computed from the averaged **corrected count-rates** that are tabulated in the **CORR_RATE** columns values from the individual sources that were merged into a source, using the appropriate calibration constants

14.19 FILTER_AB_MAG_ERR

For each filter there is a column for the source AB magnitudes.

14.20 FILTER_VEGA_MAG

For each filter there is a column for the source instrumental magnitudes. These values are computed from the averaged **corrected count-rates** that are tabulated in the **CORR_RATE** columns values from the individual sources that were merged into a source, using the appropriate calibration constants for the filter that convert count=rates to instrumental magnitudes. These magnitudes can also be referred to as "**VEGA**" magnitudes. No magnitudes are computed if the corrected count-rate exceeds 1000.

14.21 FILTER_VEGA_MAG_ERR

For each filter there is a column for the source instrumental magnitudes.

14.22 FILTER_MAJOR_AXIS

For each filter there is a column for the computed full-width-half-maximum of the source along the major-axis.

14.23 MEAN_MAJOR_AXIS

This column gives the computed value for the mean full-width-half-maximum of the source along the major-axis, using the values for each filter.

14.24 FILTER_MINOR_AXIS

For each filter there is a column for the computed full-width-half-maximum of the source along the minor-axis.

14.25 MEAN_MINOR_AXIS

This column gives the computed value for the mean full-width-half-maximum of the source along the minor-axis, using the values for each filter.

14.26 FILTER_POSANG

For each filter, this column gives the computed value for the position-angle of the major-axis source (measured anti-clock wise from the Right-Ascension axis).

14.27 MEAN_POSANG

This column gives the computed value for the mean position-angle of the major-axis source, using the values for each filter.

14.28 FILTER_QUALITY_FLAG

For each filter there is a column for the quality flag for each source, as determined from all the merged sources for that filter

14.29 QUALITY_FLAG_ST

The quality flag for each source in the boolean string form

14.30 FILTER_EXTENDED_FLAG

For each filter there is a column for the extension flag for each source, which is set equal to the extended flag of the source with the maximum significance (the negative value if a significance value is negative) for the particular filter.

14.31 EXTENDED_FLAG_MAX

This column gives the extended flag of the source with the maximum significance value (the negative value if a significance value is negative), from all the sources that were merged into a single source.

15 Notes on the Source Flags

15.1 QUALITY FLAGS

Each source has an associated "quality flag". The flag settings are shown in the following table.

BIT NUMBER	REASON	INTEGER VALUE	Region Colour
0	BAD PIXEL	1	red
1	READ-OUT STREAK	2	magenta
2	SMOKE-RING	4	yellow
3	SOURCE ON STAR-SPIKE	8	white
4	Mod-8 pattern	16	black
5	Source within central enhancement	32	red
6	Source lies near to a bright source	64	black
7	Near an edge	128	blue
8	point-source within extended source	256	blue
9	Weird source	512	red
10	Multiple exposure values within photometry aperture	1024	red

15.1.1 Examples

1. Quality flag 1 - Source contains one or more bad pixels
2. Quality flag 3 - Source contains one or more bad pixels and lies on a read-out streak
3. Quality flag 7 - Source contains one or more bad pixels and lies on a read-out streak and lies within a "smoke-ring" region.

15.1.2 Notes on individual quality flags

1. **Bad Pixels** A point-source will have this flag set if any pixel within the photometry aperture, or any within the background annulus, has a corresponding pixel in the quality image with a non-zero value. Similarly, an extended source will have this flag set if any corrsponding pixel in the quality image has a non-zero value. The quality image was added to the image file by **omcosflag**, and a "bad" pixel may either be a damaged or dead one.
2. **Weird source** Indicates that the source has an isolated extremely bright pixel.

Notes

1. **QFLAG** The quality flag for each source in each filter obtained from the input source-lists.
2. **QFLAG_COMB** The quality flag for each source in each filter obtained using the combined source-list.

16 Comments

- The package contains a Fortran-90/95 module *ommastercatalogue_mod.f90* which is called by the Perl-modules *omcat* and *omcatiau* (with different parameters) and which is actually performing the source list ingestion.

17 Future developments

The output source cataloge format might change in the future.

References